# AM/FM SYNTHESIZED SIGNAL GENERATOR

2018 (Code No. 52018-900F)

80 kHz - 520 MHz

AND

2019 (Code No. 52019-900C)

80 kHz - 1040 MHz

Serial Nos. commencing 118401

## AMENDMENT RECORD

The following amendments are incorporated in this manual.

| *Amendment No.* | *Date* | *Applies to Ser. Nos. commencing* |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

©
1981

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND.

# CONTENTS

PRELIMINARIES

Title page
Contents
Notes and cautions

CHAPTERS

1 General information
2 Installation
3 Operation

} These chapters are contained in a separate Operating Manual Vol. 1.

4 Technical description
5 Maintenance
6 Replaceable parts
7 Servicing diagrams
8 Modifications and supplements

## HAZARD WARNING SYMBOLS

The following symbols appear on the equipment

| *Symbol* | *Type of hazard* | *Reference in manual* |
|---|---|---|
| | Static sensitive device | Page (iv) |
| | Component containing beryllia | Page (iv) |

Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ ..... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear. Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

## SECURITY NOTICE

Second functions are grouped into three levels of operation. Access to the first two groups, Normal and First level operation can be freely gained by carrying out the unlocking procedures described in both Operating manual and Service manual. Details for accessing the Second level operation however, are only included in the Service manual. Some user units may wish to further restrict the distribution of this information to selected calibration areas only. To enable this, an alternative Chapter 4, page 37/38a has been included which has the unlocking procedure deleted. Users may then withdraw either page 37/38 or 37/38a as required.

Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_12517

Chapter 4

# TECHNICAL DESCRIPTION

## CONTENTS

Para.
1 Introduction
6 Overall technical description
9 Digital control system
14 Frequency synthesizer and signal processing
25 Modulation control system
31 Detailed technical description (board level)
31 AA1 - LSD loop
36 AA2 - Microprocessor system
43 AA3 - Frequency standard
47 AB1 - Output v.r.d.
55 AB2 - Divide-by-two chain and f.m. drive
61 AB3 - RF oscillators board
66 AB4 - Output phase detector
80 AB5 - Voltage controlled crystal oscillator (VCXO) loop
89 AC2 - Beat frequency oscillator (BFO) system
92 AC3/AC13 - Filter and frequency doubler board
103 AC4 - Output amplifier
111 Electronic fine attenuator
114 Insertion loss control (ILC)
117 AM processing
122 AC5 - Amplitude modulator
125 AD1 - Display board
132 AD2 - Motherboard
135 AD3 - Modulation oscillator and f.m. control
143 AD4 - Keyboard
148 AE1 - Power supply board
152 AT0 - 10 dB step attenuator
154 RPP - Reverse power protection
156 AT2 - Attenuator control
162 AG0 - GPIB adaptor module
165 Second function operations

Fig. Page
1 Simplified block diagram of 2018/2019 frequency synthesis and signal processing ... 2
2 LSD loop (AA1) ... 8
3 Microprocessor system (AA2) ... 10
4 Internal/external frequency standard (AA3) ... 12
5 Output v.r.d. simplified block diagram (AB1) ... 13
6 Divide-by-two chain and f.m. drive (AB2) ... 15
7 RF oscillators board (AB3) ... 17
8 Output phase detector (AB4) ... 18
9 VCXO loop (AB5) ... 21
10 BFO system (AC2) ... 23
11 Filter and frequency doubler board (AC3/AC13) ... 24
12 Output amplifier (AC4) ... 27
13 Amplitude modulator (AC5) ... 30
14 Modulation oscillator and f.m. control (AD3) ... 33

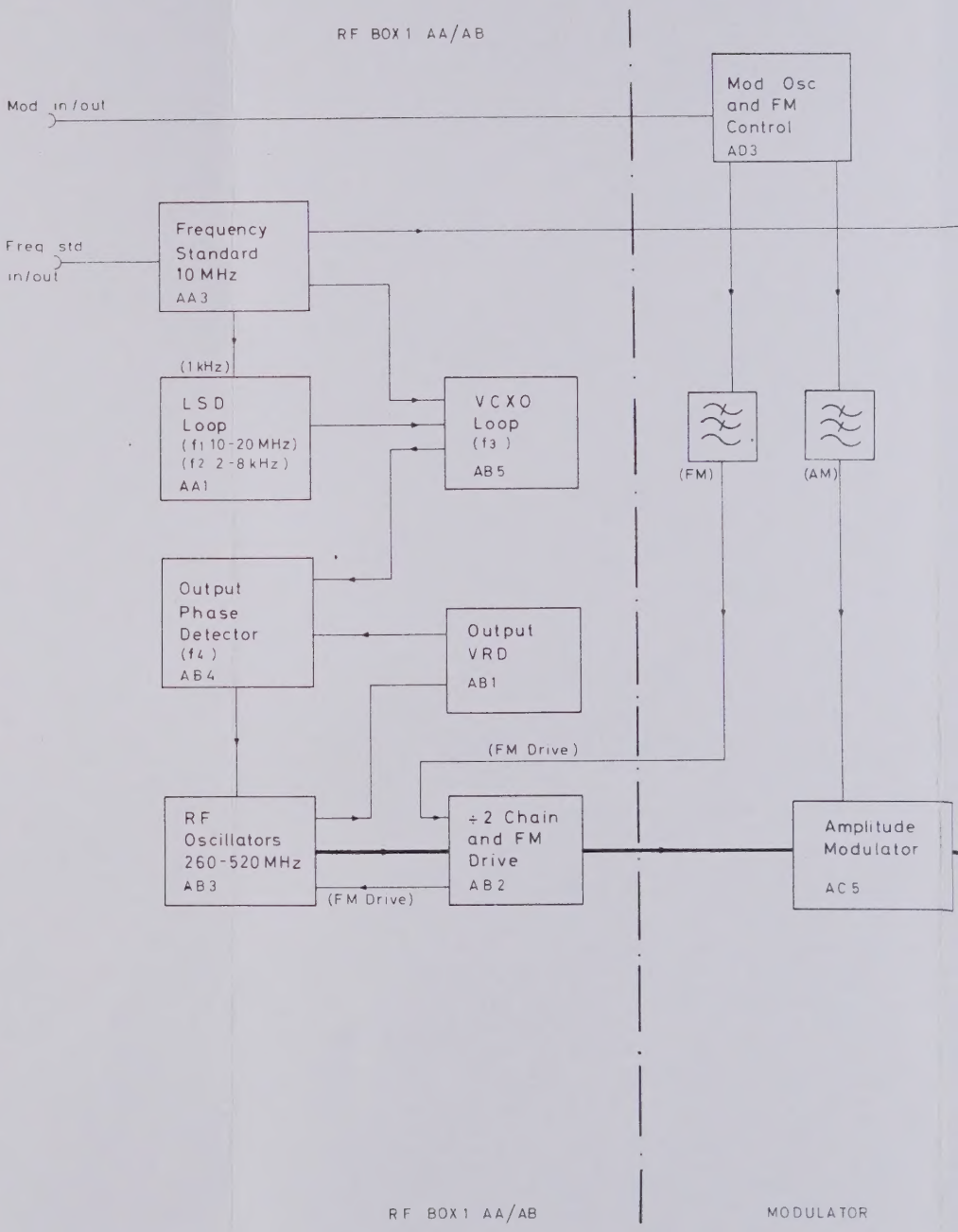
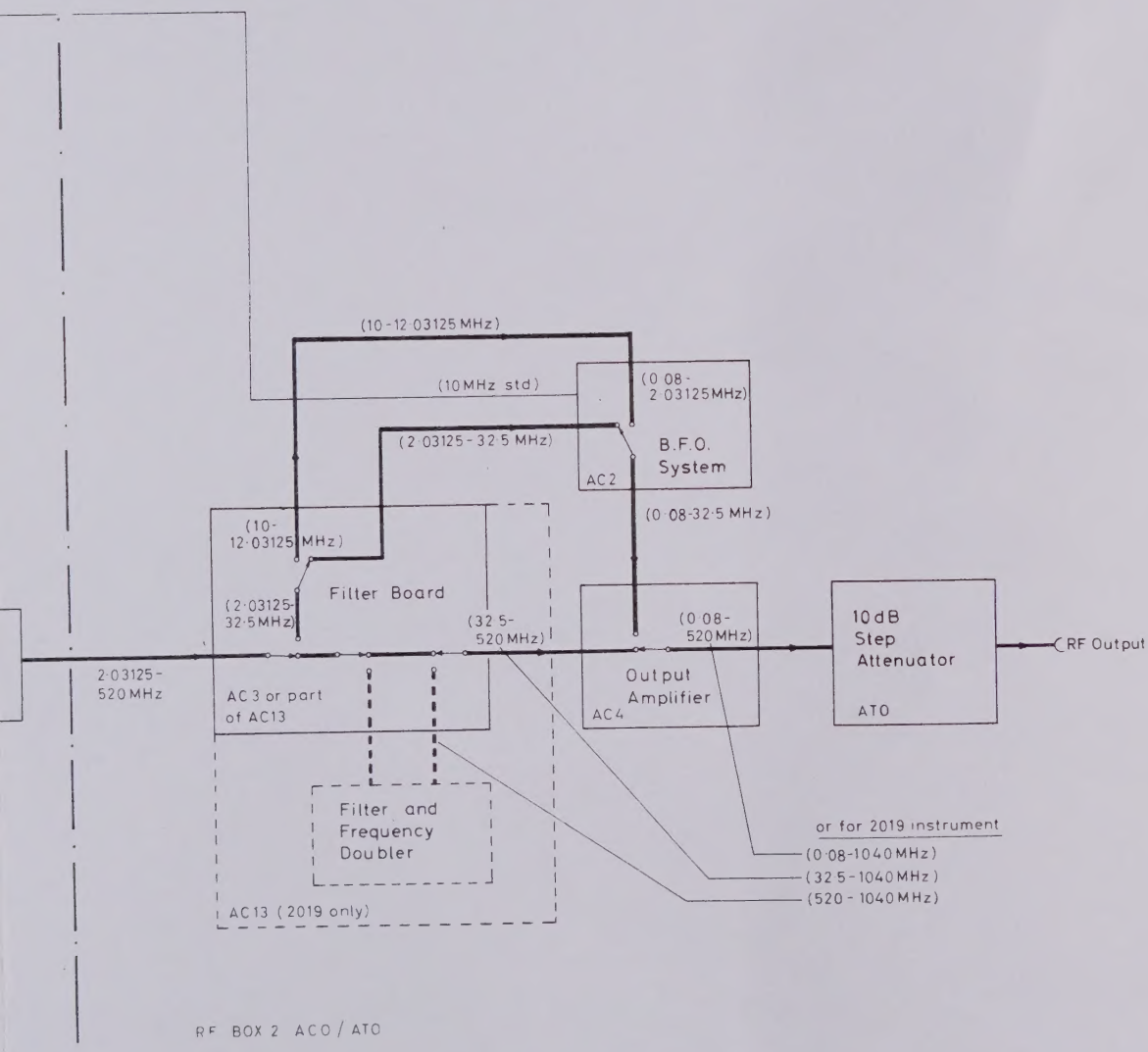



*Fig. 1 Simplified block diagram o*
*sig*




*m of 2018/2019 frequency synthesis and*
*ignal processing*

## INTRODUCTION

1. The 2018 is a 0.08 MHz to 520 MHz synthesized signal generator providing calibrated output levels from 13 dBm to -127 dBm. 2019 is a 0.08 MHz to 1040 MHz synthesized signal generator similar to 2018 except that a frequency doubler circuit enables it to cover frequencies up to 1040 MHz with the same output level range. The output frequency of both 2018 and 2019 is phase locked to a frequency standard and can be set to a resolution of 10 Hz at frequencies up to 520 MHz and to a resolution of 20 Hz above 520 MHz (2019 only).

2. Both instruments can be frequency modulated or amplitude modulated from external or internal modulation sources. The internal modulation source provides five fixed modulation frequencies; re-selection of components within the instrument allows alternative frequencies to be set if required.

3. Calibrated output levels from -127 dBm to +13 dBm (0.2 μV to 2 V e.m.f.) in the c.w. and f.m. modes and up to +7 dBm (1 V e.m.f.) in the a.m. mode are provided. A choice of nine output level calibration units can be obtained on the front panel. The r.f. output level can be set to a resolution of 0.1 dB or better over the entire output voltage range and features a total cumulative accuracy of ±1 dB up to 520 MHz (±2 dB, 520 MHz - 1040 MHz). Protection against the accidental application of up to 50 W of reverse power is provided by a fast responding reed relay.

4. Front panel operation is carried out by direct entry of required settings via the keyboard. Microprocessor control ensures maximum flexibility and allows programming by the General Purpose Interface Bus (GPIB). This facility is offered as an optional accessory enabling the instrument to be used both as a manually operated bench instrument or as part of a fully automated test system. Facility is also made for the use of an external standard reference when this is preferred.

5. A second function mode of operation includes means of setting the GPIB address, selection of alternative r.f. level calibration units, access to various calibration routines and a facility to aid diagnostic fault finding.

## OVERALL TECHNICAL DESCRIPTION

6. The 2018/2019 signal generator is divided into three main areas. The first area is the digital control system by which the microprocessor board AA2 receives and sends data to the various p.c.b's in the instrument. This is accomplished by means of an internal instrument bus.

7. The second area consists of a frequency synthesizer and the analogue signal conditioning circuits that are controlled by the data bus in order to produce the required output signal.

8. The third area is the modulation control system controlling the audio signals used to amplitude modulate (a.m.) or frequency modulate (f.m.) the carrier output.

Digital control system

*Circuit diagram : Chap. 7, Fig. 3*

9. The internal data bus consists of a total of 17 control lines. The first eight lines D0 to D7, are data lines. The data bus is bi-directional e.g. data may be input into the microprocessor via the front panel keyboard or control data can be sent to the data latches from the microprocessor.

10. The next four lines A0 to A3, are address lines. These are used to control the address of the latch to which the data is to be sent or from which data is being read.

11. The following four lines A4 to A7 are data valid lines. A0 to A3 lines are fed to address decoders and with it one of the data valid lines A4, A5, A6 or A7 is connected to each address decoder. Only when this line is activated '0' low is the decoder enabled, and its decoded output then activates the required data latch.

12. The last control line A8 is the GPIB interrupt line. This line calls for the microprocessor to service the GPIB module.

13. Bus interconnections are shown in Chap. 7, Fig. 5 Servicing diagrams. The microprocessor AA2 serves as the motherboard in the top r.f. box. Some of the data is latched on AA2 in order to minimize the number of interconnections. The addresses of the other latches are also decoded on AA2 to minimize interconnections. The entire 17 line data bus is connected to AD2 motherboard via an r.f. filter box. The filter box ensures that r.f. signals are not conducted down the data bus. From the motherboard the data bus is distributed to the boards outside the top r.f. box. A further connection is made to the lower r.f. box containing AC2, AC3, AC4 and AC5 via a second filter box.

Frequency sunthesizer and signal processing

*Circuit diagram : Chap. 7, Fig. 1*

14. The frequency synthesizer provides a stable frequency source at the output of AB3 RF oscillators board covering the frequency range 260 MHz to 520 MHz that is phase locked to the internal frequency standard, board AA3 with a resolution of 10 Hz. As an aid to deriving the frequency at any point in the synthesizer the output frequency from AB3 is considered to be of the form

$$fo = m \times 100000 + n \times 10$$

where m is between 2600 and 5200
n is between 0000 and 9999

If an output frequency of 512.34567 MHz is selected then m = 5123 and n = 4567 and the output

$$fo = \frac{2\,(m-1)}{200}\left[10^7 + \frac{(10^4 + n)\,10^3}{m-1}\right]$$

Intermediate frequencies at significant points within the synthesizer are given as f1, f2, f3 and f4 and are shown on the simplified block diagram Chap. 7, Fig. 1. Each frequency can be determined by applying one of the following formulae :

$$f1 = (10^4 + n)\ 10^3 = 14.567000 \text{ MHz}$$

$$f2 = \frac{(10^4 + n)\ 10^3}{m-1} = 2.844006 \text{ MHz}$$

$$f3 = 10^7 + \frac{(10^4 + n)\ 10^3}{m-1} = 10.002844 \text{ MHz}$$

$$f4 = \frac{10^7 + \frac{(10^4 + n)\ 10^3}{m-1}}{200} = 0.05001422 \text{ MHz}$$

$$fo = \frac{2\ (5122)}{200}\left[10^7 + \frac{(10^4 + 4567)\ 10^3}{5122}\right] = 512.34567 \text{ MHz}$$

15. The least significant digit (l.s.d.) loop, board AA1 phase locks an oscillator covering the frequency range 10 to 20 MHz to multiples of 1 kHz. The resulting signal is divided by m-1 in a variable ratio divider (v.r.d.) before being fed to the voltage controlled crystal oscillator (v.c.x.o.) board AB5. Its frequency is then between 2 and 8 kHz.

16. VCXO board AB5 then phase locks to the sum frequency of 10 MHz and the 2 to 8 kHz signal from AA1. The resulting 10.002 to 10.008 MHz signal is divided by 100 before being fed to AB4 Output phase detector board. The phase detector on AB4 is used to lock the oscillators on AB3 to the required output frequency. AB3 output is divided by 2(m-1) by a v.r.d. on board AB1. The resulting signal has a frequency of between 50.01 and 50.04 kHz and is fed to AB4.

17. If the instrument has not been set to provide f.m. the phase detector system operates at the frequency of 50.01 to 50.04 kHz. However if f.m. is selected, the phase locked loop bandwidth is reduced to avoid the loop removing the required f.m. The frequencies are then divided by 5 before phase comparison and an alternative phase detector and loop filter is used with a lower gain. The resulting signal from AB3 is therefore a 260 to 520 MHz carrier phase locked to the internal frequency standard and is frequency modulated if required. The divide-by-two system on AB2 divides the output from AB3 so that it can provide output frequencies of between 2.03125 MHz and 520 MHz. The output at this point is a nominal square wave.

18. The output from AB2 is connected via a semi-rigid cable to AC5 Amplitude modulator in the lower r.f. box. AC5 contains a double balanced mixer that is used as an amplitude modulator. The resulting amplitude modulated signal is then passed on to AC3 or AC13 board. These are different versions of the same board, AC3 Filter board in 2018, or AC13 Filter and frequency doubler board in 2019. If the output signal level from the instrument is required to be greater than +7 dBm then AC5 is set to give its peak envelope power of nominally -5 dBm provided the amplitude modulation is off. The output from AC5 is nominally a square wave.

19. The signal into AC3/AC13 is divided into two main paths. Frequencies of 2.03125 MHz to 32.5 MHz are routed via a buffer amplifier to a bank of filters operating in a 200 Ω characteristic impedance system. The filters convert the square wave into a sinusoidal signal. In order to generate a 0.08 to 2.03125 MHz band a 10 MHz to 12.03125 MHz signal is routed to AC2 BFO system where the signal is mixed with 10 MHz from the internal frequency standard and filtered to produce an 80 kHz to 2.03125 MHz sine wave. Frequencies below 80 kHz may be selected but the accuracy of the r.f. level output will be impaired.

20. The output from AC2 is a nominal 40 mV, 80 kHz to 32.5 MHz sine wave operating in a 200 Ω system. This signal is fed to AC4 Output amplifier board where it is amplified by a variable gain amplifier, the gain of which is controlled by two j.f.e.t's used as voltage controlled variable resistors. The output from the variable gain amplifier is connected to the output stage amplifier where the output signal level is detected by an r.f. detector. The resulting d.c. signal is compared to a variable reference voltage by a comparator. The comparator output controls the gain of the j.f.e.t. variable amplifier so as to obtain the correct output level from AC4.

21. The 32.5 MHz to 520 MHz signal on AC3/AC13 is switched to an amplifier and a 520 MHz low-pass filter. If the instrument is a 2019 the signal can then be switched to a frequency doubler and filter system to generate a 520 to 1040 MHz signal.

22. In both 2018 and 2019 the signal from the 520 MHz low-pass filter goes through a filter bank to produce a sinusoidal output signal which is then fed to AC4 output amplifier.

23. The 32.5 to 520 MHz (or 1040 MHz for 2019) signal is amplified by a pin diode controlled variable gain amplifier and is then connected to the output stage. The output level from AC4 is controlled by an a.l.c. system consisting of an r.f. detector, comparator and two variable gain amplifiers (j.f.e.t. and pin diode controlled). The level is normally varied over the range +7 dBm to −3 dBm by controlling the reference voltage to the a.l.c. If levels greater than +7 dBm are requested and the a.m. is off the level is increased up to a maximum of +13 dBm. The reference voltage to the a.l.c. is also varied to compensate for the insertion loss of the attenuator, cables and connectors that connect the output signal to the front panel.

24. The attenuator provides electro-mechanical attenuation of the output signal from AC4. Provision is made to attenuate the output signal in 10 dB increments from 0 dB to 120 dB. The attenuator output is connected to a reverse power protection system (RPP) which protects the attenuator pads from the accidental application of reverse power. The RPP uses a coaxial reed relay to open circuit the output of the signal generator and can be reset from the front panel or by the GPIB.

Modulation control system

*Circuit diagram : Chap. 7, Fig. 1*

25. The internal modulation oscillator is a Wien bridge type and can be programmed to provide one of five fixed frequencies. These can be altered by the user simply by changing two resistor values for each frequency. If internal modulation is selected the modulation oscillator is connected to the MOD INPUT/OUTPUT socket on the front panel. If external modulation has been selected the modulation oscillator is disconnected from the front panel and the external source is connected directly to the two attenuators shown on the simplified block diagram Chap. 7, Fig. 1.

26. The audio a.l.c. uses a j.f.e.t. controlled attenuator to produce a fixed output audio voltage provided that the input audio voltage is between 0.8 V and 1.2 V r.m.s. If external modulation is selected the audio a.l.c. may be switched on or off by the front panel MOD ALC key. If internal modulation is in use audio a.l.c. is always switched on.

27. The a.m. signal is amplified on AD3 board and routed via the motherboard AD2 to the filter box on the lower r.f. box and then to AC5 Amplitude modulator. An 8 bit digital to analogue (D-A) converter is used to control the audio level according to the required modulation depth.

28. The f.m. signal is connected to an 8-bit D-A which controls the signal level in accordance with the f.m. tracking data. This data is stored in the microprocessor board AA2 EAROM store. The f.m. tracking data is stored at 84 frequencies across the fundamental octave band of the instrument (260 to 520 MHz). The microprocessor provides a straight line interpolation between these carrier frequency points and sends the resulting data to the 8-bit D-A.

29. The signal is then processed by a 10-bit D-A, this controls the signal level in accordance with the required f.m. deviation. The 10-bit D-A also takes account of the scaling factors introduced by following D-A's and the frequency division of the carrier by the r.f. signal conditioning circuit.

30. The f.m. drive signal is attenuated by an 8-bit D-A which divides the audio signal level by successive factors of two. This effectively sets the f.m. range. The signal is then fed to a filter box on the upper r.f. box, and from there to AB2 Divide-by-two chain and f.m. drive board. This board provides further variable division of the signal level by factors of four using reed relay switches to provide further scaling of the f.m. range. The output of AB2 is then connected to AB3 RF oscillators to frequency modulate the oscillator.

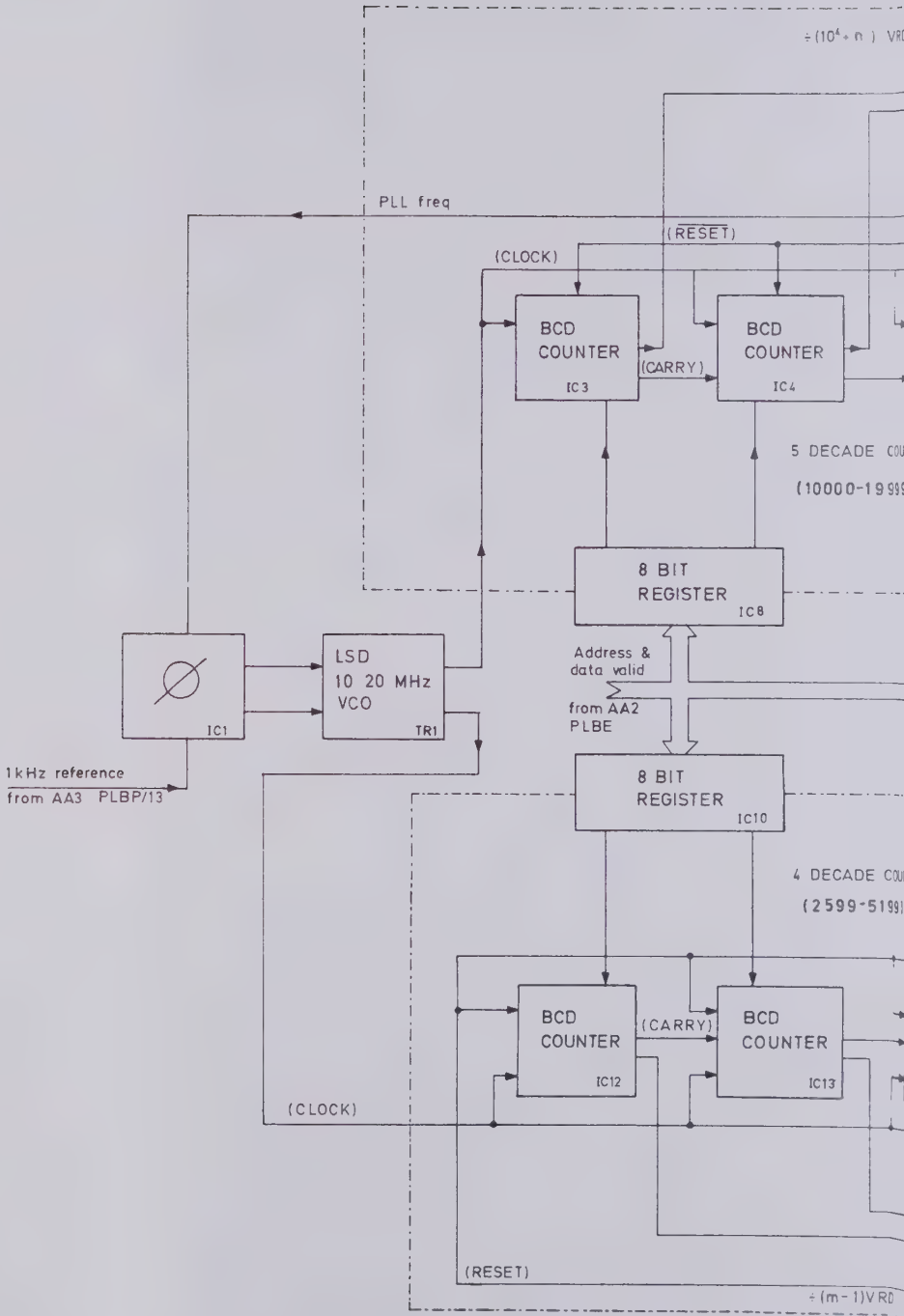
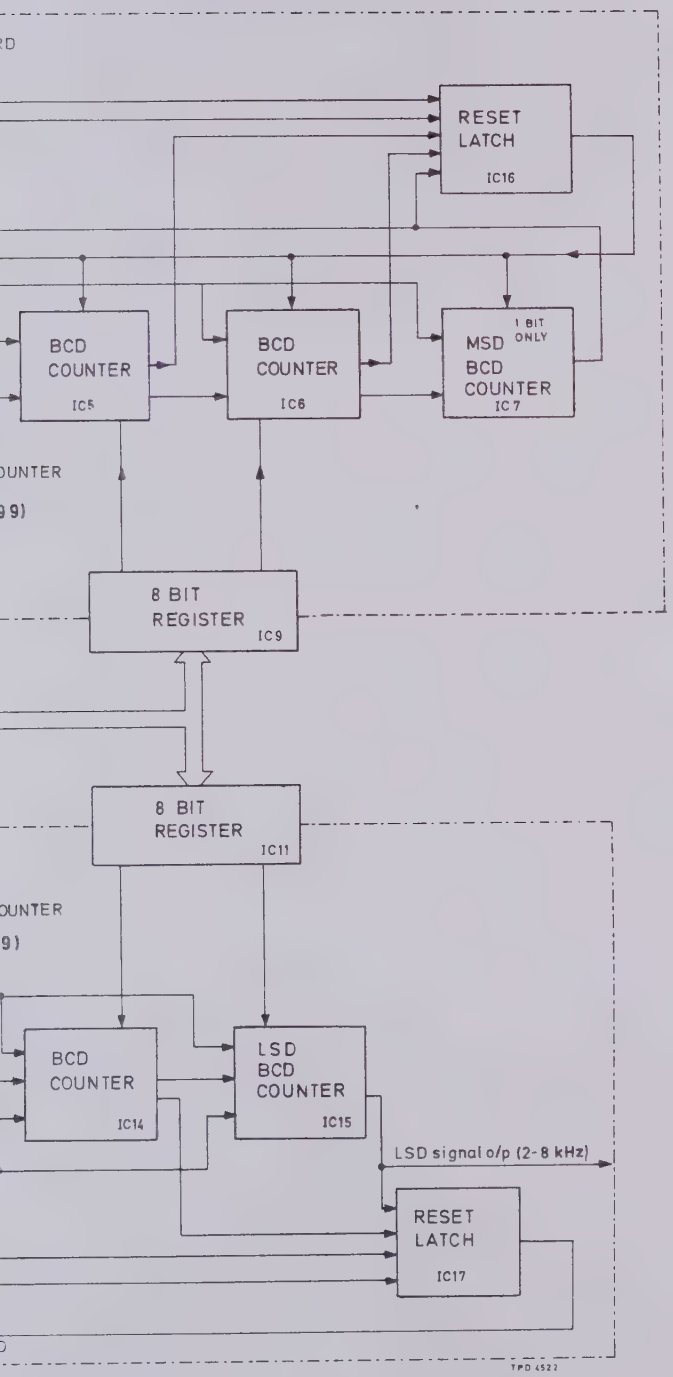

÷(10⁴÷n) VRD
PLL freq
(RESET)
(CLOCK)
BCD COUNTER IC3
(CARRY)
BCD COUNTER IC4
5 DECADE COU
(10000-19999
8 BIT REGISTER IC8
Address & data valid
from AA2 PLBE
IC1
LSD 10 20 MHz VCO TR1
1kHz reference from AA3 PLBP/13
8 BIT REGISTER IC10
4 DECADE COU
(2599-5199
BCD COUNTER IC12
(CARRY)
BCD COUNTER IC13
(CLOCK)
(RESET)
÷(m-1)VRD

*Fig. 2 LSD*


RESET
LATCH
IC16
BCD
COUNTER
IC5
BCD
COUNTER
IC6
1 BIT
ONLY
MSD
BCD
COUNTER
IC7
8 BIT
REGISTER
IC9
8 BIT
REGISTER
IC11
BCD
COUNTER
IC14
LSD
BCD
COUNTER
IC15
LSD signal o/p (2-8 kHz)
RESET
LATCH
IC17

# DETAILED TECHNICAL DESCRIPTION (BOARD LEVEL)

## (AA1) - LSD loop

*Circuit diagram : Chap. 7, Fig. 6*

31. This board contains the circuits which control the four least significant digits (LSD) of the carrier wave output frequency. The board provides the reference input to the phase detector on the voltage controlled crystal oscillator (VCXO) loop AB5. Control data for the LSD loop is brought to four 8-bit latches IC8 to IC11 via the instrument bus.

32. The LSD loop consists of a phase locked loop built around a 10-20 MHz voltage controlled oscillator (VCO) whose output is divided by a five decade variable ratio divider (VRD) and then fed to a phase detector where it is phase compared with a 1 kHz reference signal derived from the frequency standard board AA3. The output from the phase detector is filtered and the resulting d.c. signal is used to control the VCO. The control voltage changes the VCO frequency so as to annul any phase error at the phase detector, and establish phase lock. The modulus of the VRD controls the frequency of the VCO.

33. After buffering, the VCO signal is fed to each clock input of the five decade counters IC3 to IC7 comprising the VRD. The VRD will count upwards whilst the 8 (QD) and 1 (QA) output of each counter are monitored by a multi-input NAND gate IC16. When all the monitored outputs reach the high state the $\overline{\text{RESET}}$ line will go low '0'. On the arrival of the next clock pulse, the data held in the latches IC8 and IC9 is loaded into the counters. The data consists of the nines complement of the required division ratio (IC7 is hard-wired to load in 8). Because a clock pulse is required for reloading the counter this pulse does not increment the counter. To compensate for this missed pulse the NAND gate IC16 is wired to detect the VRD state 99998 for the end of each count sequence rather than 99999. The VRD is capable of dividing by any integer value between 10000 and 19999.

34. The $\overline{\text{RESET}}$ line in the VRD also drives one input of the phase detector, IC1, the other being driven by the 1 kHz reference signal. If the $\overline{\text{RESET}}$ frequency is below 1 kHz, a stream of current pulses will be driven into the loop filter (C1, C2, R1) by transistor TR2, this raises the VCO control voltage causing the $\overline{\text{RESET}}$ frequency to rise towards 1 kHz. Similarly if the $\overline{\text{RESET}}$ frequency is above 1 kHz, a stream of current pulses will be drawn from the loop filter by transistor TR3 to lower the control voltage. When phase coincidence is obtained, equal but opposite pulses by TR2 and TR3 are produced thus maintaining the correct control voltage; these pulses are typically 30 nanoseconds wide.

35. Another buffered output from the VCO goes to a four decade VRD (IC12 to IC15) which works in a similar manner to the one described above. The microprocessor ensures that the modulus of this VRD falls between 2599 and 5199, according to the required carrier wave output frequency. The LSD signal output is available at PLBN and has a frequency range of approximately 2 kHz to 8 kHz.

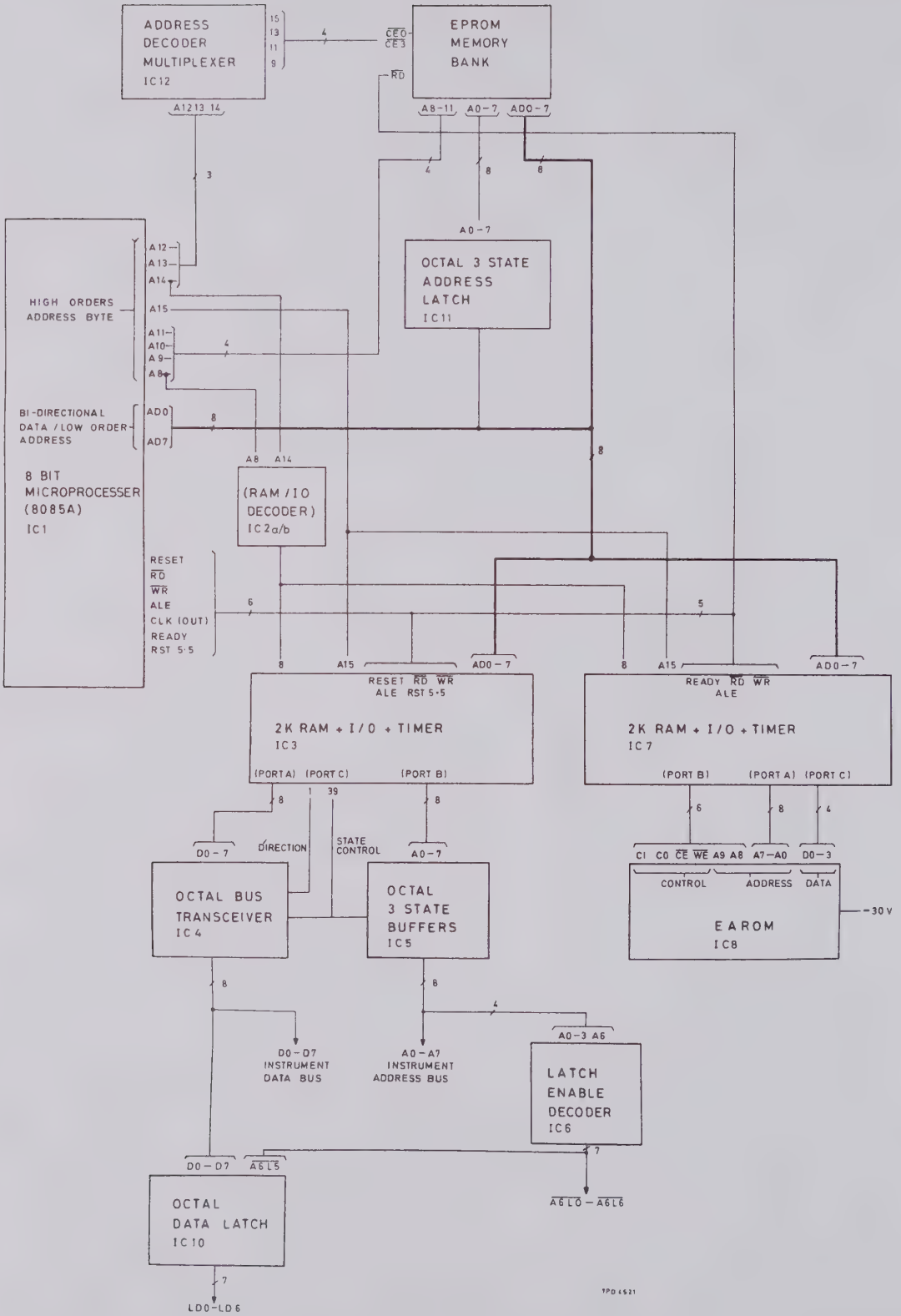



*Fig. 3 Microprocessor system (AA2)*

(AA2) - Microprocessor system

*Circuit diagram : Chap. 7, Fig. 7*

36. The microprocessor board AA2 contains the whole system necessary to drive both address and data bus lines which control the instrument. The 8085A microprocessor IC1 has an 8-bit multiplexed data/low order address bus which is demultiplexed by the latch IC11.

37. The program is contained in IC13, 14, 15 and 16, all of which are ultra violet-erasable PROM's. These are enabled by IC12 which decodes A12 and A13 of the address bus, and is itself disabled by A14 high (addresses 4000 to 7FFF hexadecimal). The program space is thus contiguous from address 0000 to 3FFF.

38. IC3 and IC7 each contain 256 bytes of RAM (read/write), which is addressed contiguously from address 4000 to 41FF. Port A (pins 21 - 28) in IC3 carries the instrument's 8-bit bi-directional data bus via a bus transceiver IC4, and Port B (pins 29 - 36), the instrument's address bus. This is in the form of 4 address lines (bits A0 - A3) and uncoded data valid lines (bits A4 - A7) giving a total of 64 available latch addresses.

39. The mode of operation of the address bus is that the required address is presented to the bus with bits A4 - A7 high and the bus is allowed to settle. Then the required data valid line is activated by pulling it low, which either latches the information on the data bus onto the addressed latch (for outputs from the microprocessor) or allows the addressed data source to drive the data bus (for inputs to the microprocessor: either from keyboard or GPIB board). The data valid lines are thus only activated when a valid (and stable) address is present on the other 4 address lines. The direction of the data bus buffer is controlled by a line on Port C of IC3 (pin 39).

40. IC6 is the decoder for the first 7 addresses served by data valid line A6 (i.e. it supplies chip enables corresponding to bus addresses A6L0 to A6L6), and IC10 is the A6L5 data latch, used to hold the information which selects which oscillator is in use via AB4, and other signal routeing information on AA3.

41. The three ports on IC7 are used to control the data flow in and out of IC8, which is a 4k bit non-volatile read/write memory. Since the memory is arranged as 1k x 4 bit bytes, there are 4 data lines and 10 address lines, so whilst the data bits are on Port C (pins 1, 37-39), the address lines are divided between Port A (pins 21-28), which carries the least significant 8 bits, and Port B (pins 29-34), which carries A8 and A9 in addition to the 4 control lines required to instruct IC8.

42. In order to write into or erase IC8, a supply of -30 V must be made available. To avoid accidental corruption of the stored data, this supply is made software switchable (via pin 35 of IC7 Port C), and incorporates protection circuitry to avoid accidental enabling of the supply when switching on and off. The -30 V is generated by a diode-capacitor voltage doubler (D5, D6 and C17) fed from TR5 and TR6, which are in turn driven by an oscillator, part of IC9. This is switched on or off by TR1 and TR7. TR8 and TR9 form a network to detect the failure of the +5 V supply when the instrument is switched off, ensuring that the oscillator is also held off. TR2 and TR3 ensure that whenever the oscillator is stopped, the -30 V supply is pulled up to +5 V: TR4 acts as a buffer to switch off the -30 V output when this pull up occurs.

(AA3) - Frequency standard

*Circuit diagram : Chap. 7, Fig. 8*

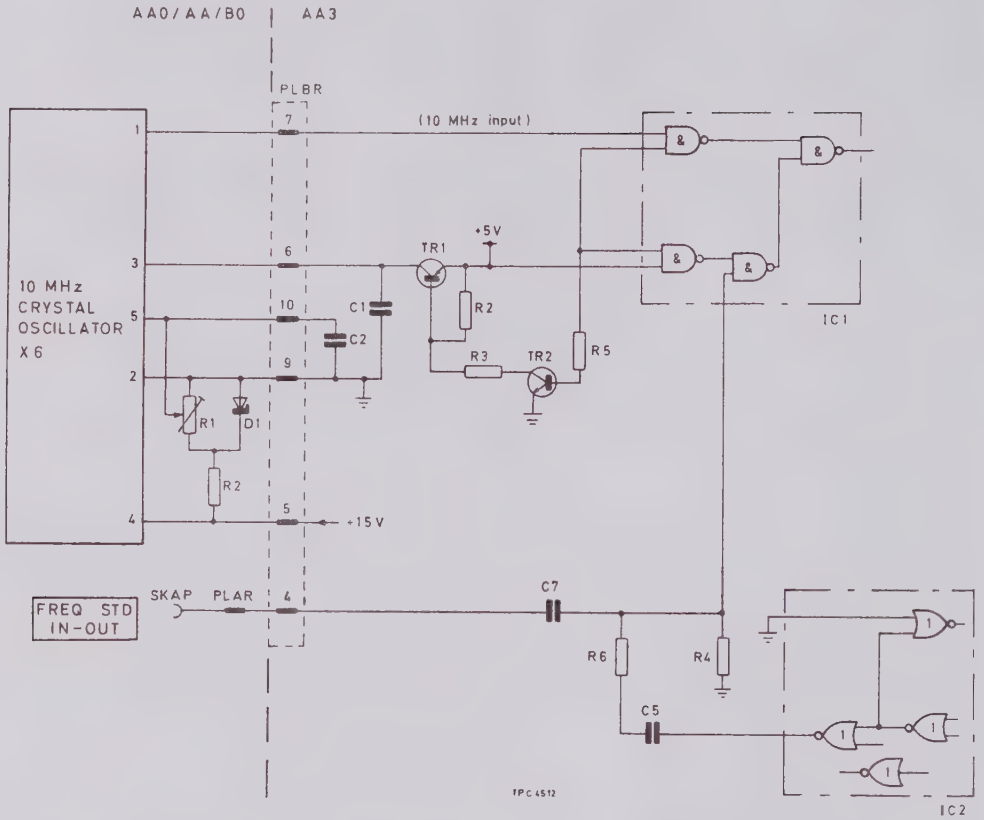



*Fig. 4 Internal/external frequency standard (AA3)*

43. The purpose of board AA3 is to select the required frequency standard and to distribute the necessary reference frequencies derived from the standard throughout the instrument. Control data is brought on two lines from a latch on the microprocessor AA2, via feedthrough capacitors and PLBP pins 5 and 10. If the INT/$\overline{\text{EXT}}$ STD line is high, the voltage supply to the temperature controlled crystal oscillator is turned on and its 10 MHz output frequency appears on PLBR pin 7.

44. The potentiometer AA0,R1 provides the means of trimming the crystal oscillator frequency. The oven supply is permanently on and is drawn from PLBR, pin 5. The logic gates are enabled so that the 10 MHz signal appears on IC1 pin 3. The output of IC1 is fed to the VCXO loop, AB5, via TR3, and also to the rear panel via PLBR, pin 4. The output to the VCXO loop is nominally a sine wave, the square wave drive being filtered by the tuned circuit L1 and C9. The 10 MHz standard is also divided down to 1 kHz by ÷100 dividers IC3, IC4 and then routed to the LSD loop via PLBP pin 13.

45. If the INT/$\overline{\text{EXT}}$ line is low the internal crystal oscillator is switched off and PLBR, pin 4 is used to input the external frequency standard from the rear panel socket.

46. If the BFO $\overline{ON}$ line is low another 10 MHz output is taken from IC3 (whichever standard, INT or EXT is in use) and fed via BLBR pin 14. This is used to generate the BFO band of 80 kHz to 2.03125 MHz on AC2. The diode D1 provides isolation when the BFO system is not in use.

## AB1 - Output v.r.d.

*Circuit diagram : Chap. 7, Fig. 9*

47. The board AB1 contains the high speed variable ratio divider (v.r.d.) which is used in the output phase locked loop to control the four most significant digits of the carrier wave output frequency. The v.r.d. is driven by a signal from the r.f. oscillator board, AB3, and provides the signal for the output phase detector, AB4. Control data for the v.r.d. is fed to two eight bit latches IC4 and IC5 via the instrument bus.

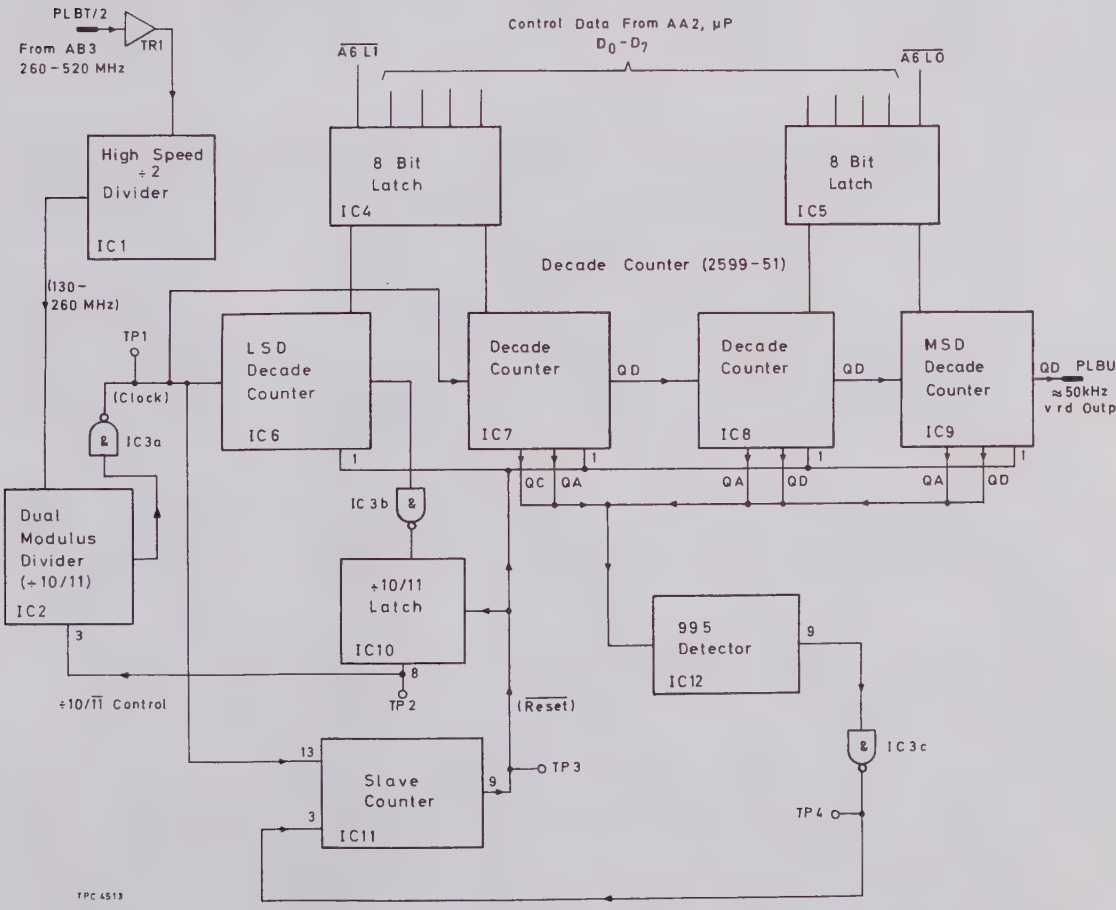



*Fig. 5 Output v.r.d. simplified block diagram (AB1)*

48. The r.f. input signal of approximately -6 dBm is amplified by TR1 and fed to a divide-by-two prescaler, IC1, to produce a frequency between 130 - 260 MHz at the input to IC2, pin 1. To operate at such a high speed a dual modulus (divide-by-10/11) counter system is used.

49. The dual modulus counter, IC2, initially divides by 11 its control line ÷10/$\overline{11}$ low, when the control line is high its modulus is 10. The state of this control line can change at any time whilst counting, but before the arrival of the eleventh pulse. Thus the time period available for a change of the control line is approximately ten times the input clock period.

50. The output from the 10/11 counter drives the clock line, (TP1), for the chain of the presettable decade counters. Each counter is loaded with a nines complement number and counts upward with each pulse (falling edge at each pin no. 8). The two least significant counters, IC6 and IC7 are incremented simultaneously.

51. The 10/11 counter IC2 starts in the modulus 11 mode. After every 11 input pulses IC6 and IC7 are both incremented. When IC6 output reaches 9 (1001 in b.c.d.) a low level appears at IC3b, pin 3 causing TP2 to go high to set the 10/11 counter to divide by 10. IC7 is then incremented every 10 input pulses.

52. IC8 and IC9 are driven in cascade from IC7. IC6 will continue to count but there will be no further change at TP2 until the $\overline{\text{RESET}}$ pulse occurs. "The early decode" method is used at the end of each v.r.d. sequence in order to reset the decade counters for the next sequence. When the counters IC7, IC8 and IC9 reach the state 995, TP4 is asserted high, and the last four pulses at TP1 are counted by IC11 slave counter.

53. The pulse 997 will cause the $\overline{\text{RESET}}$ control line TP3 to be asserted low. This reloads the four decade counters to the nines complement data held in the 8-bit latches IC4 and IC5. Pulse 999 will cause TP3 to assert high once more to enable the counters and also to clock the flip-flop IC10 resetting TP2 low. This reverts IC2, the dual modulus counter to the modulus 11 mode and so the v.r.d. is ready for the next count sequence.

54. The microprocessor AA2 ensures that the modulus of the v.r.d. falls between 2599 and 5199 according to the required carrier wave output frequency. The v.r.d. output is taken from the '8' output (QD) of IC9 to PLBU, pin 2 and has a frequency of just over 50 kHz.

AB2 - Divide-by-two chain and f.m. drive

*Circuit diagram : Chap. 7, Fig. 10*

55. Board AB2 has two functions, the majority section is used for the divide-by-two chain and a minor section for the f.m. drive. The purpose of the divide-by-two chain is to divide the carrier frequency from AB3 down to the carrier frequency selected by the front panel keyboard or via the GPIB. The input frequency to AB2 is between 260 MHz and 520 MHz. Up to seven divide-by-two elements can be switched in to provide frequency cover from 260 MHz down to 2.01325 MHz.

56. If no division of the basic frequency is required (frequencies in the range 260 MHz - 520 MHz) the signal is instead routed directly to the output socket SKBX. Frequencies below 2.01325 MHz are derived on a different board, for details see (AC2) BFO system.

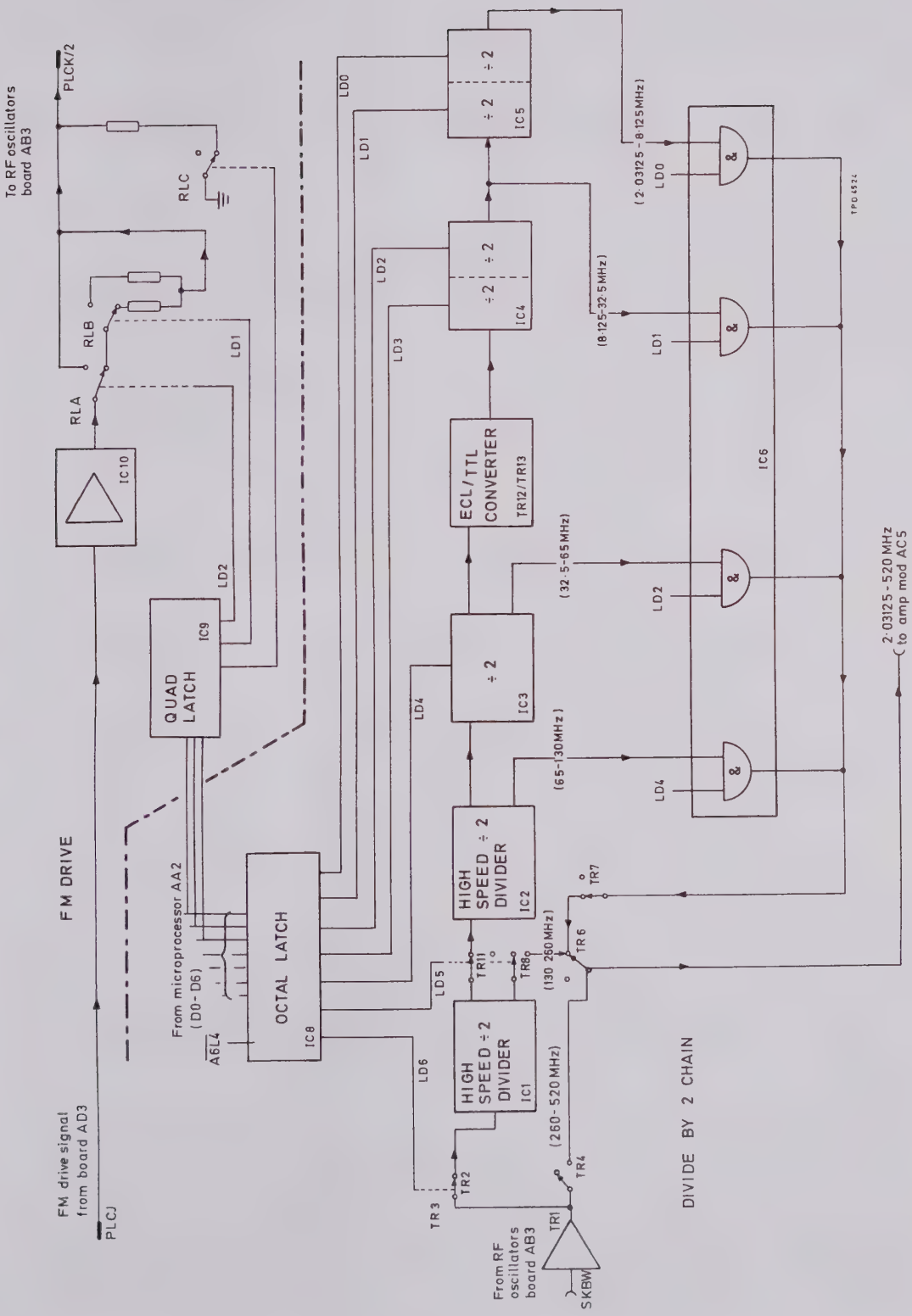



*Fig. 6 Divide-by-two chain and f.m. drive (AB2)*

57. Seven bits of control data from AA2 microprocessor D0 - D6 are used to control the dividers, these are fed to IC8 octal latch via the instrument bus. Different logic technologies are used to implement the chain of dividers and consequently different methods are used to switch elements in and out.

58. The input signal of approximately -6 dBm comes in on SKBW and is amplified by TR1. It is then routed according to the state of latch output LD6 either

(1) To the output socket SKBX via TR4, other control lines ensure that TR6 is held off, or

(2) The state of LD5 controls the divided signal of IC1 which is either routed through TR8 and TR6 to the output (TR4 and TR7 both held off) or alternatively, used to clock the second divider IC2.

(3) Similarly, LD4 determines whether the output from IC2 is routed through IC6, TR7 and TR6 to the output or is used to clock the next divider IC3 and so on. Transistors TR12 and TR13 form an e.c.l. to t.t.l. interface. The two flip-flops in IC4 are driven synchronously with the control lines setting the division to divide-by-two or four as required. IC5 operates in a similar way.

59. The divider outputs are gathered together in an e.c.l. wired-OR configuration (IC6, TR7, TR8) so that at the output socket SKBX, all frequencies from 2.03126 - 520 MHz are available the nominal level being 0 dBm.

60. The f.m. drive circuit on AB2 provides the coarse adjustment of the f.m. drive voltage delivered to the r.f. oscillators on AB3. Three bits of control data D0 - D2 are used and brought to the quad latch IC9 via the instrument bus. The f.m. drive signal is on PLCJ from where it is fed to IC10 voltage follower which in turn drives a network of switched resistors. These are operated by relays RLA, RLB and RLC. With all the relays energized, maximum f.m. drive signal is applied to the r.f. oscillators AB3, and each relay de-energized decreases the drive by a factor of four.

AB3 - RF oscillators board

*Circuit diagram : Chap. 7, Fig. 11*

61. Board AB3 contains the main oscillators for the instrument. Four oscillators each one covering a quarter octave frequency range between 260 MHz and 520 MHz. Only one oscillator is ever turned on at any time and its output frequency is phase locked to the required output frequency by the phase detector AB4. Each oscillator can be frequency modulated by a signal from AB2. The board is contained in a solid aluminium box to reduce microphony to a minimum.

62. Each oscillator uses a resonant circuit with a maintaining transistor capacitively coupled to maintain oscillation. The tuning inductor is a printed track which can be adjusted using a sliding link. Varactor diodes are used to voltage tune the oscillator. Chip capacitors are used to tap the transistors TR2, 4, 7, 9, into the tuned circuit. This avoids spurious resonances. Care must be taken when attempting to solder chip components, for details see Chap. 5, Maintenance, Introduction. Each oscillator is designed to have a substantially linear f.m. tracking curve which is instrumental in reducing f.m. distortion and noise.

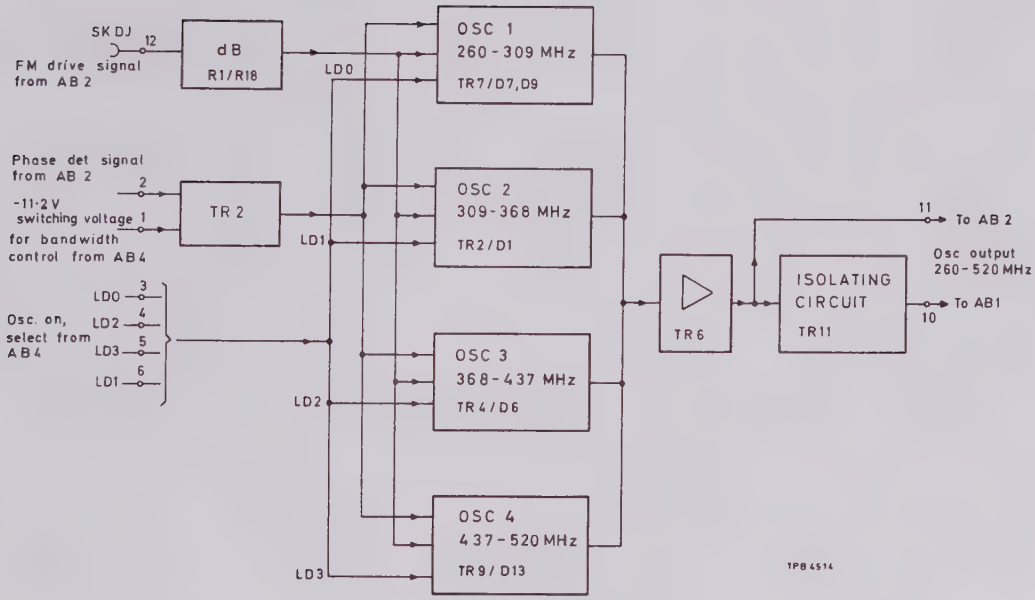



*Fig. 7 RF oscillators board (AB3)*

63. The required oscillator is turned on by connecting tag 3, 4, 5 or 6 to a negative voltage on AB4. This supplies emitter current to the required maintaining transistor. The collector current of the transistor forward biases diodes connected to its collector and therefore connects the r.f. signal to the amplifier TR6. Two outputs from TR6 are taken, one direct via tag 11 to AB2 board for frequency division, the second is via isolating transistor TR11 and tag 10 to the output v.r.d., AB1, to phase lock the carrier frequency. The nominal output from both tag 10 and tag 11 is -6 dBm.

64. The oscillators are frequency modulated by a signal appearing on tag 12. This signal is attenuated by R18 and R1 and is then applied to the anode of each varactor diode via r.f. chokes L2, L5, L7 and L11. The main frequency control is achieved by the phase detector signal on tag 2. It is connected to the cathode of each varactor via an R-C network consisting of R2, R3, TR1 and C8. When the f.m. is on the phase locked loop bandwidth is low and TR1 is switched off by connecting tag 1 to -11.2 V on AB4. R2 and C8 then have a long time constant and filter signals appearing on tag 2.

65. When the f.m. is off the loop bandwidth is increased in order to reduce the frequency settling time. The j.f.e.t. TR1 is then turned on so that the R-C time constant is formed by R3 and C8. This prevents potential feedback instability.

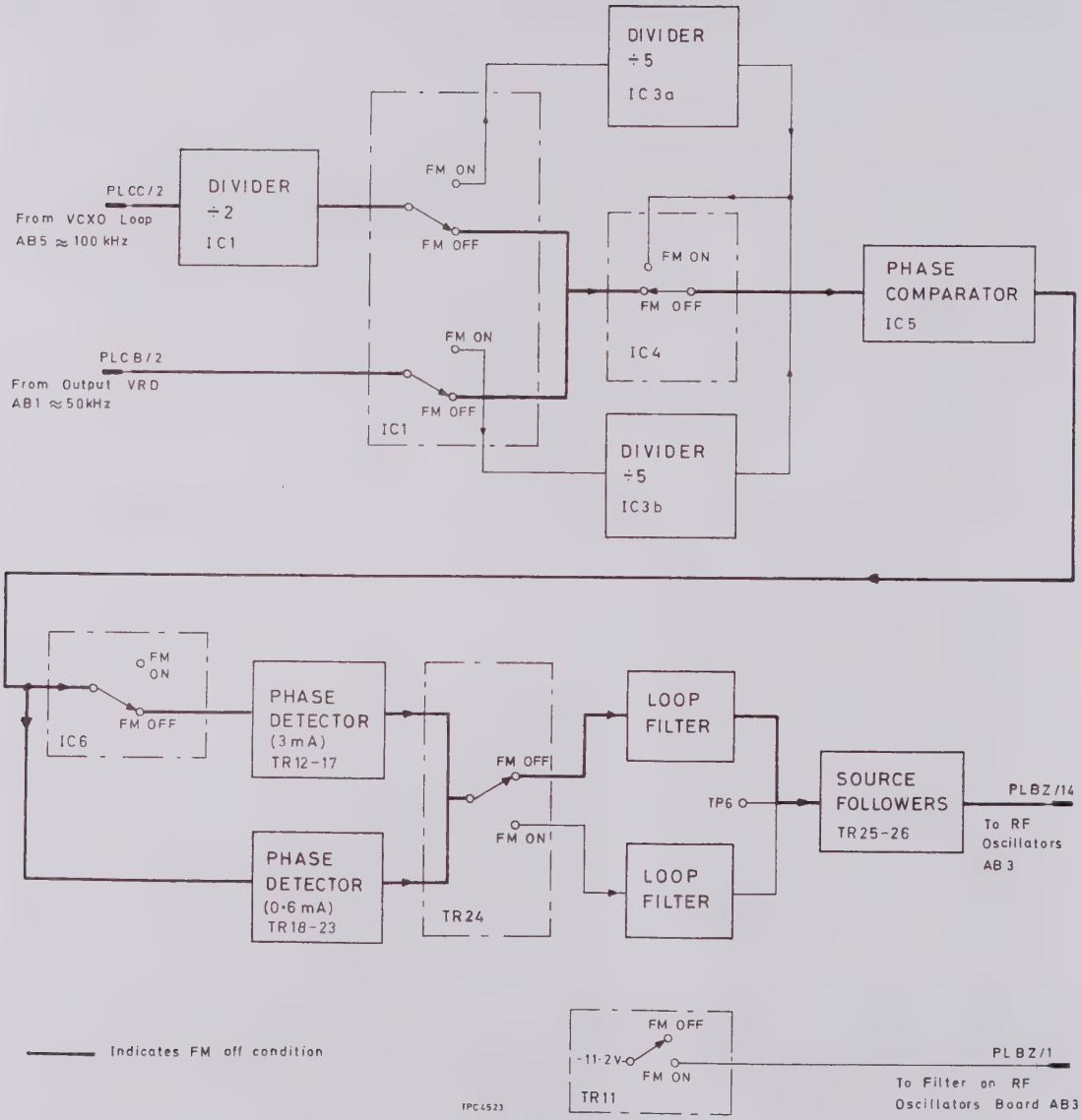



*Fig. 8 Output phase detector (AB4)*

AB4 - Output phase detector

*Circuit diagram : Chap. 7, Fig. 12*

66. Board AB4 contains the phase comparator used to lock the output frequency from AB3 output oscillators to the selected frequency. It also contains voltage regulators to provide low noise power supplies for AB3 and transistor switches TR1 - TR4 with IC8, to switch the required AB3 oscillator on.

67. The output from AB5 v.c.x.o. loop inputs on PLCC, pin 2. Its frequency is approximately 100 kHz. The frequency is then divided by two in part of IC1. The resulting 50 kHz square wave is then routed to the phase comparator IC5 by one of two routes. If the f.m. is off the phase locked loop bandwidth is high and the 50 kHz signal is routed via IC4 to IC5.

68. If the f.m. is on, the loop bandwidth should be lower in order to avoid the loop interfering with the required f.m. This is reduced by several methods. The phase detector current is reduced by a factor of 50 and the loop filter time constants are altered by switching in resistors R41, R42. In addition the phase detector operating frequency is changed from 50 kHz to 10 kHz. When the f.m. is on, the divide-by-five circuit in IC3a is enabled by IC1, pin 5 and its output is routed via IC4 to the phase comparator IC5.

69. Similarly the nominal 50 kHz signal from AB1 - Output v.r.d. is routed to the phase comparator, IC5 via IC4 also, and if the f.m. is on its frequency is divided by five in IC3b before reaching IC5 via IC4.

70. In order to minimize any transient frequency change when switching the f.m. on or off the f.m. on/off instruction on PLBY, pin 5 is latched by IC1 so that the divide-by-five circuits of IC3 are synchronously enabled.

71. Phase comparator, IC5 compares the phase of the signals on pins 3 and 11. If the frequency on pin 3 is higher than that on pin 11, IC5 will produce a string of pulses on pin 6. If the frequency on pin 3 is lower than that on pin 11, IC5 will produce a string of pulses on pin 8. When the signals are phase locked by the loop IC5, pins 6 and 8 are normally low except for a 30 ns pulse.

72. Phase detectors, there are two, TR12 to TR17 and TR18 to TR23, these differ only in that the first phase detector operates at 3 mA and the second at 0.06 mA. If the f.m. is off both the phase detectors operate. If the f.m. is on the 3 mA detector (TR12 - TR17) is turned off by IC6 and so the gain of the phase locked loop is reduced. Because both phase detectors operate in a similar manner only one is described.

73. The signal on IC6, pin 11 is level shifted by TR12 and used to control a differential pair formed by TR14 and TR15. The signal on TP1 switches either TR15 or TR14 on. When TR15 is switched on its base voltage is established by the Zener diode D1 and current flows from R21 into TR15. This current charges up the loop filter formed by C14, R42, R41, TR24 and C13. Similarly TR13 level shifts the waveform on IC6, pin 6, in order to control the differential pair TR16, TR17. When TR17 is on charge is drawn out of the loop filter.

74. If the loop looses lock either TR15 or TR17 (assuming f.m. is off) is switched on by the pulses from IC5 and either increases or decreases the charge on the loop filter and hence changes the voltage on TP6 in the direction required to regain phase lock. At phase lock TR15 and TR17 are off except for a nominal 30 ns time interval when both transistors are on. If the f.m. is on TR15 and TR14 are held off and TR21 and TR23 control the loop filter.

75. Loop filter time constants, these are switched by TR24 according to whether the f.m. is on or off. When the f.m. is on TR24 is switched on by TR9. This makes the time constants of C14, C13 short to ensure stability in the loop. If the f.m. is off the loop bandwidth is reduced and the time constants of C13, C14 are increased by turning TR24 off. The loop filter is earthed on the box containing AB3 via PLBZ pin 5. This reduces mains hum and phase detector related interference.

76. The phase detector output on TP6 is buffered by the source follower TR25, transistor TR26 is a second source follower that ensures the source-drain voltage of TR25 is low in order to minimize gate leakage current (j.f.e.t's suffer leakage due to impact ionization if their drain-source voltage is high). The output from TR25 source is then fed to AB3 via PLBZ pin 14 to control AB3 oscillators.

77. The signal on PLBZ, pin 1 controls a filter time constant on AB3 board. When the f.m. is on PLBZ, pin 1 is connected to -11.2 V via TR11. If the f.m. is off, TR11 is switched off and PLBZ, pin 1 is pulled to the same voltage as PLBZ, pin 14 by R49. Note that PLBZ, pin 1 is a high impedance point and can only be monitored by a high impedance probe.

78. IC2 and IC7 are voltage regulators that produce -11.2 V and +11.5 V supplies for use on AB3 and AB4. This ensures that the supplies to oscillators are free from hum and noise.

79. The required oscillator on AB3 is switched on by the circuits formed by TR1 to TR4 and IC8 as determined by the lines LD0 to LD3 derived from AA2 microprocessor board.

## AB5 - Voltage controlled crystal oscillator (VCXO) loop

*Circuit diagram : Chap. 7, Fig. 13*

80. The board AB5 phase locks a v.c.x.o. to a frequency equal to the 10 MHz frequency standard plus the output frequency from AA1, LSD loop. The output from AB5 is used as the reference by AB4 output phase detector.

81. TR1 is the maintaining transistor for a v.c.x.o. using tuning elements L1, L2, D2, XL1, C3 and C4. The Zener diode D1 provides a regulated +12 V supply to the oscillator. The varactor diode, D2, enables the oscillator to be voltage tuned over the frequency range 10.002 MHz to 10.008 MHz.

82. The output signal from TR1 collector is connected to IC1 where the signal is converted to t.t.l. levels. The output from IC1 pin 13 is used to drive IC3 which divides the frequency by 100. The output from IC3, pin 9 is then fed to AB4 via PLCF, pin 2.

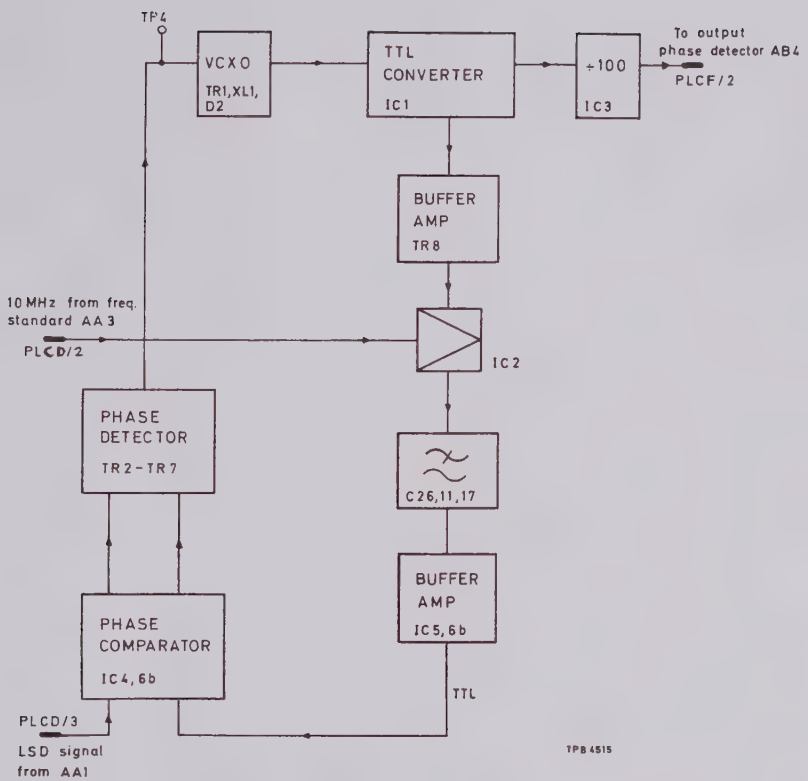



*Fig. 9 VCXO loop (AB5)*

83. The output from IC1, pin 10 is used to drive the phase locked loop to lock the v.c.x.o. to the selected frequency. The output is level shifted and buffered by TR8 and the signal on the collector of TR8 is used to drive a double balanced mixer, IC2. Pin 10 of IC2 is a.c. coupled to ground by C9 so the v.c.x.o. frequency appears across pins 8 and 10, this serves as the local oscillator for the mixer. The linear input for IC2 mixer is developed across pins 1 and 4 and is a 10 MHz sinusoidal signal derived from AA3 frequency standard via PLCD, pin 2.

84. IC2 mixes the 10 MHz signal with the v.c.x.o. frequency to produce an audio difference frequency on IC2, pin 6. IC2, pin 12 is also connected to pin 6 via C26, this is an anti-phase component and provides cancellation of the sum product and possible local oscillator breakthrough (at high frequencies) further filtering is provided by C11.

85. The resulting signal is then a.c. coupled by C17 in order to produce a signal referenced to ground at IC5, pin 3. R20, R21, C20, C25 provide further filtering of the audio signal. The comparator IC5 converts the audio signal into a nominal t.t.l. compatible square wave at IC5, pin 7. This signal is fed to phase comparator IC4 via IC6a.

86. The phase comparator is formed by IC4 and IC6b comparing the phase of the signals on pins 3 and 11. The signal on pin 3 is the output frequency from AA1, LSD loop. If the frequency at pin 11 is higher than that at pin 3 a series of pulses will appear at pin 8. If the frequency at pin 11 is lower than at pin 3 a series of pulses will appear at pin 5.

87. The outputs from IC4 drive a phase detector and loop filter to control the v.c.x.o. TR6 and TR7 are level shifting transistors that drive two differential pairs TR3, TR2 and TR4, TR5. The differential pairs inject current pulses into the loop filter formed by C1, R35, C2. If the v.c.x.o. frequency is low TR5 is turned on by the pulses from IC4, pin 5 and the voltage on TP4 will be increased to regain phase lock. Similarly if the v.c.x.o. frequency is high TR2 will be turned on by the pulses on pin 8 and the voltage on TP4 will be decreased to attain phase lock. At phase lock both TR2 and TR5 are normally off except for a short interval of about 30 ns when both transistors are switched on by narrow pulses from IC4.

88. IC7 is a voltage follower that buffers the voltage on TP4. The resulting d.c. signal is used to control the varactor diode D2 and hence the frequency of the v.c.x.o.

AC2 - Beat frequency oscillator (BFO) system

*Circuit diagram : Chap. 7, Fig. 15*

89. Carrier frequencies below 2.03126 MHz are generated in a b.f.o. on this board by mixing a signal of 10 - 12.03125 MHz with the 10 MHz standard. The resulting signal is filtered leaving only the difference frequency, which is then fed to the output amplifier AC4.

90. The 10 - 12.03125 MHz signal input at PLCV, pin 1 is buffered by TR2 and applied to the linear port, pin 1 of mixer X1. The 10 MHz signal, from the frequency standard, at PLCU, pin 2 is amplified by TR1 and applied to the local oscillator port, pin 8 of the mixer. The process of mixing produces sum and difference signals at the i.f. port, pins 3, 4. A low-pass filter (2.1 MHz) L1, L2, C5 - C8 suppresses the sum component so that TR3 is fed with a signal of 80 kHz - 2.03125 MHz. T1 transformer prevents breakthrough of mixer input frequencies (particularly 10 MHz) on the b.f.o. output, and allows the earth plane to be split; this helps to contain the r.f. earth currents. After T1 the signal passes through a second 2.1 MHz low-pass filter, L3, L4, C17 - C20, to join a common 1.f. channel output to AC4 via D1, C21 and PLCW, pin 1.

91. For b.f.o. operation the d.c. voltage on PLCW, pin 3 is high (controlled from AC3/AC13) so that D2 is off and D1 is on. D2, together with other diodes on AC3/AC13, prevent 10 - 12.03125 MHz signal breakthrough on the output from AC2. If b.f.o. operation is not required (carrier frequency >2.03125 MHz) PLCW, pin 3 is low, consequently D2 is on and D1 is off. This allows the 1.f. channel input at PLCW, pin 3 to be routed direct to AC4 via PLCW, pin 1. At the same time the 10 MHz and 10 - 12.03125 MHz signals are turned off.

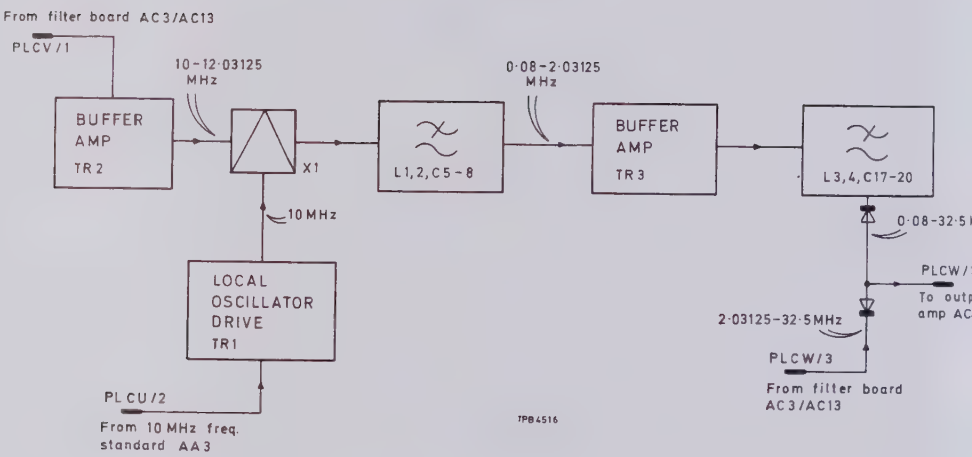



*Fig. 10 BFO system (AC2)*

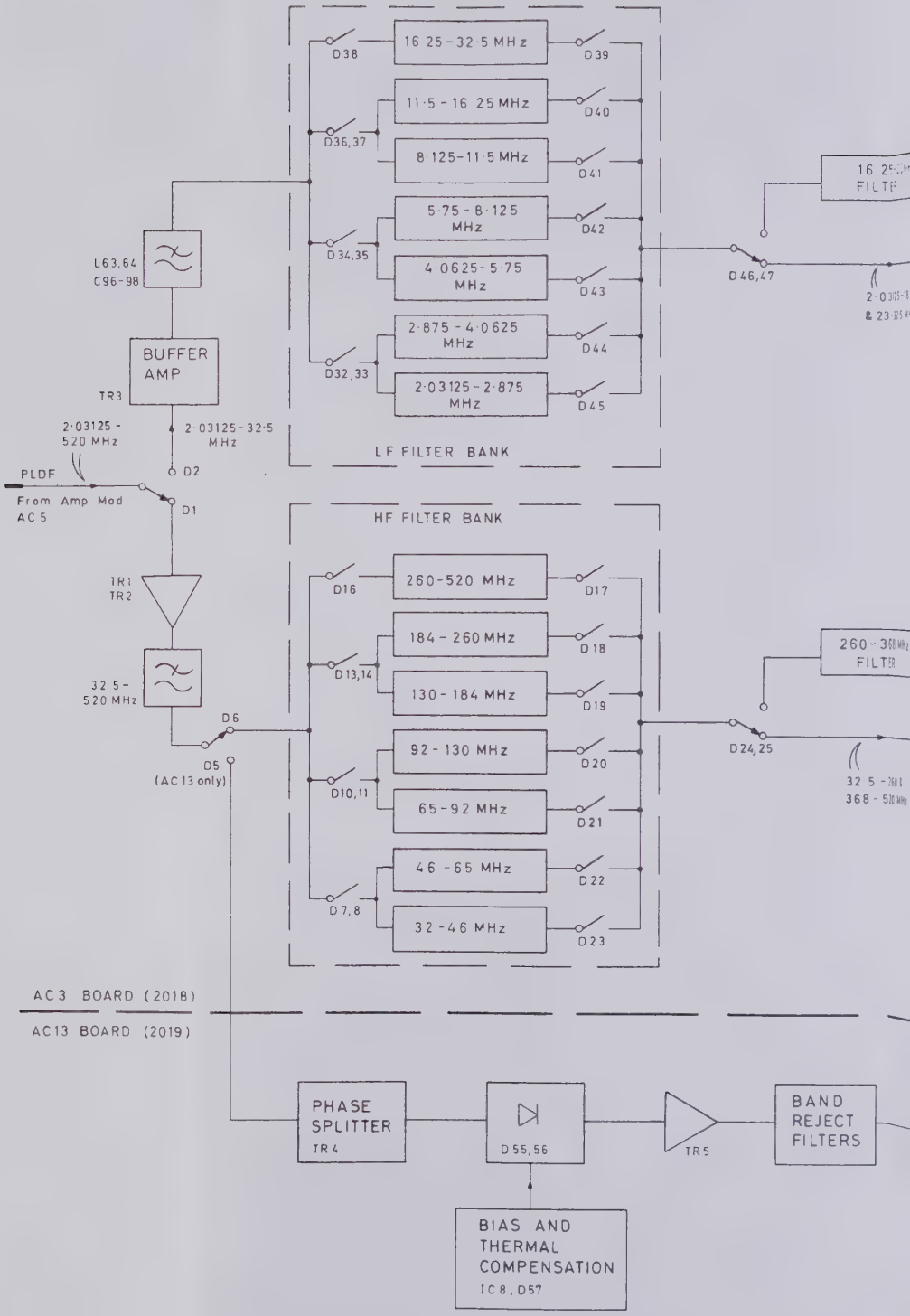
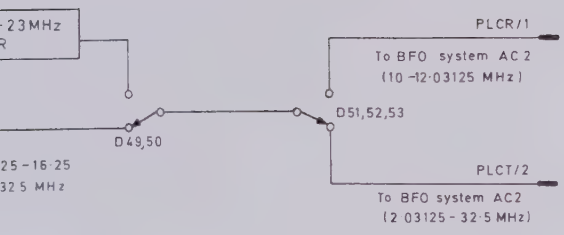
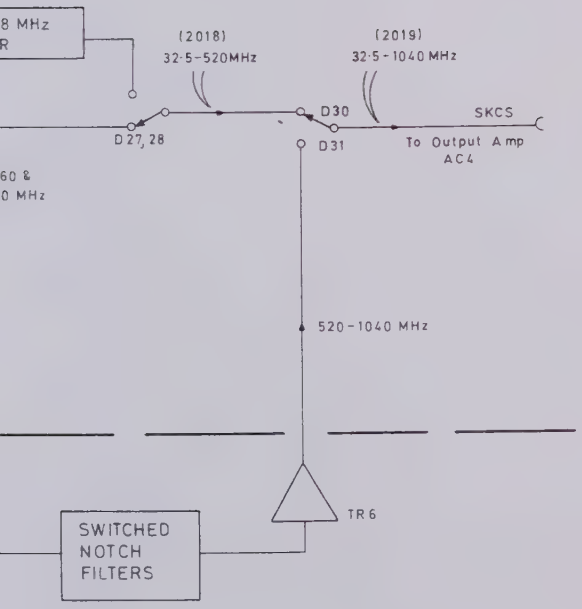



*Fig. 11 Filter and frequency doubler board (AC3/AC*


PLCR/1
To BFO system AC 2
(10 -12·03125 MHz)
D51,52,53
D49,50
PLCT/2
To BFO system AC2
(2 03125 - 32·5 MHz)


(2018)
32·5-520MHz
(2019)
32·5 - 1040 MHz
D30
SKCS
D27, 28
D31
To Output Amp
AC4
520 - 1040 MHz
TR 6
SWITCHED
NOTCH
FILTERS

IPD4527

## AC3/AC13 - Filter and frequency doubler board

*Circuit diagrams : Chap. 7, Figs. 16 and 19*

92. The same printed circuit board is used for AC3 and AC13. AC13 is used in 2019 and has both filter and frequency doubler circuits; AC3 is used in 2018 having only the filter circuits (the components for the frequency doubler not fitted). A dashed line in the board legend marks the boundary between the two circuit areas.

93. The filter circuits provide harmonic filtering of the r.f. signal from AC5 by means of switched low-pass filters. The frequency doubler circuit doubles the input frequencies 260 - 520 MHz supplied to it to provide frequency cover for the 2019 up to 1040 MHz. The output signals from AC3/AC13 are fed to the output amplifier, AC4. (Frequencies below 32.5 MHz are fed via AC2).

94. AC3/AC13 also performs the bus address decoding for r.f. box 2 ('C' Deck), and the decoded address lines (A7L0 - A7L6 from IC1) are routed to their respective latches on AC5, AC4, AC3/AC13. The power supplies for AC5, AC4 and AC2 are distributed from AC3/AC13. The control data for AC3/AC13 is brought to IC2, IC3 and IC6 via the instrument bus.

95. Filters. The r.f. signal at PLDF is switched into the h.f. channel (32.5 - 520 MHz) by D1 if the $\overline{\text{HF}}$/LF line, IC3, pin 2 is low, or into the l.f. channel (2.03126 - 32.5 MHz) by D2 if the line is high. The h.f. channel input is amplified by TR1 and TR2 (+10 dB gain) and then filtered by the 520 MHz low-pass filter L6, L7, C20-C22. If the FREQUENCY DOUBLER $\overline{\text{IN}}$/OUT line, IC3, pin 12, is high, D6 is turned on and the r.f. signal passes to the main h.f. filter bank.

96. If the carrier frequency is between 32.5 and 260 MHz one of the half-octave low-pass filters in the main h.f. filter bank (L13 - L24) will be selected according to the data latched on IC2, pins 12, 15, 16, 19 and IC3, pin 5. If the frequency is between 260 and 520 MHz the bypass, D16, D17 is selected. The main h.f. filter bank output passes through C50.

97. For frequencies between 260 and 368 MHz the 368 MHz low-pass filter is switched in by turning on D25,D27 by the 368 and 23 MHz l.p.f's IN/$\overline{\text{OUT}}$ 'high' instruction on IC3, pin 6. For all other frequencies this line is 'low' and signals pass through D24,D28. If the frequency doubler is not included D30 is turned on by the FREQUENCY DOUBLER $\overline{\text{IN}}$/OUT 'high' instruction, this is inverted by IC5e and the output is then taken from SKCS.

98. The h.f. channel operates in a 50 Ω system, but the l.f. channel operates in a 200 Ω system. The necessary impedance transfer in the l.f. channel is accomplished by the buffer TR3. LF channel signals from TR3 are first filtered by the 32.5 MHz low-pass filter L63, L64, C96 - C98 and then pass to the main l.f. filter bank. This operates in a similar manner to the h.f. filter bank but uses the data on IC2 pins 2, 5, 6, 9 and IC3, pin 5. The 23 MHz low-pass filter is switched by IC3, pin 6, and the common output routed through C95.

99. For carrier frequencies of 2.03126 MHz - 32.5 MHz the b.f.o. line, IC3 pin 9, is high, turning D52 on and D51 and D53 off, connecting the output from C95 through to PLCT, pin 2.

100. For carrier frequencies below 2.03126 MHz the b.f.o. line is low turning D51 and D53 on and D52 off. The b.f.o. board, AC2, is supplied with a 10 - 12.03125 MHz signal via PLCR, pin 1 which is mixed on AC2 with the 10 MHz standard to give the required carrier frequency. D53 helps to prevent breakthrough of l.f. channel frequencies on the b.f.o. output.

101. Frequency doubler (520.00002 MHz - 1040 MHz). The input to phase splitter and frequency doubler is taken from after the 520 MHz low-pass filter. A transistor phase splitter, TR4, feeds the matched pair of diodes D55 and D56 in full wave rectification configuration. A bias supply is derived from a third diode (D57), matched with the other two. This ensures thermal compensation and a sensibly linear output over a wide range of level. Thus a.m. will be virtually unaffected by the doubler. The output from the frequency doubler is then amplified by TR5.

102. The output from the frequency doubler contains both sub-harmonics and harmonics which must be improved by filtering. The filter must reject the sub-harmonic and harmonics while allowing the required frequency to pass with low insertion loss. This is effected by a series of band reject filters. Switching between capacitive elements is carried out with diodes and at two break frequencies, 660 MHz and 820 MHz, in order to give the frequency responses required. Capacitors C119, C120, C123, C124, C135, C136 form switched notch filters that attenuate the sub-harmonic components in the output. The output from the frequency doubler is then amplified by TR6 before being routed to the output connector, SKCS, via the diode switch D31.

AC4 - Output amplifier

*Circuit diagram : Chap. 7, Fig. 17*

103. This board contains the r.f. output amplifiers, the automatic level control (a.l.c.) circuits, the electronic fine attenuator, and the insertion loss control (i.l.c.). It receives h.f. channel signals from AC3/AC13, l.f. channel and b.f.o. signals from AC2, and delivers a levelled and calibrated output signal with a 50 Ω source impedance to the coarse attenuator AT0. Control data for the amplifier switching, fine attenuator and i.l.c. is brought to AC4 via the instrument bus.

104. HF channel and a.l.c. This is selected by a 'high' instruction on IC2, pin 5, and a 'low' on IC2, pin 9. TR5 is then turned on and supplies current to the h.f. channel amplifiers, whilst TR16 is off. The h.f. input (frequencies greater than 32.5 MHz) at PLCS is amplified by four r.f. transistor stages. The first two, TR2, TR4, give +6 dB each but the gain can be trimmed at the 1 GHz end by moving R9, R19 along L2, L4 respectively. The last two stages (common with the l.f. channel) have a combined gain of +10 dB. At high frequencies the gain of TR10 tends to fall; to compensate for this the gain of TR8 is held down at low frequencies but allowed to rise with frequency.

105. High frequency gain can be trimmed by moving R34, R35 along L7. Diodes D8 - D10 protect TR10 from voltage transients. All four stages use active bias networks, TR1, 3, 7 and 9.

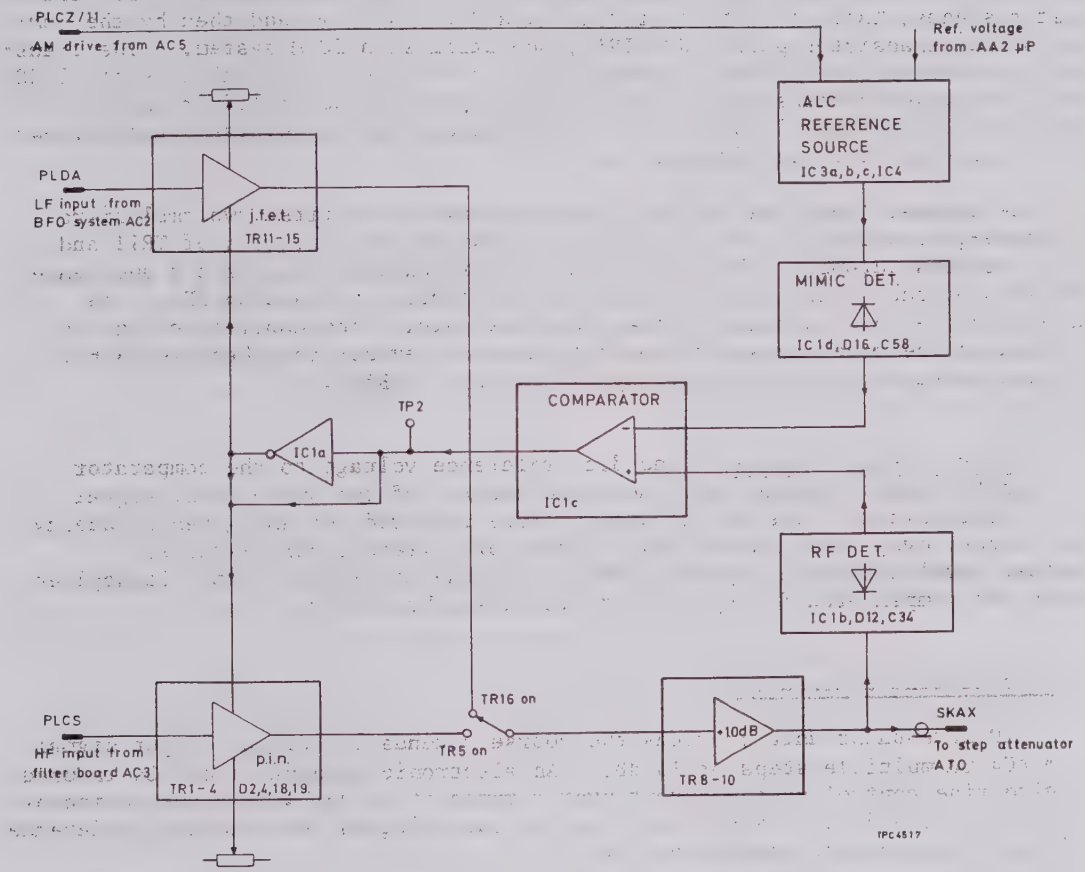



*Fig. 12 Output amplifier (AC4)*

106. RF level control for the h.f. channel is accomplished using pin diode attenuators in the r.f. amplifier chain. The two fixed-gain stages, TR2 and TR4 are placed between three pin diode attenuator elements, D18-19, D2 and D4. The attenuation produced by these diodes is determined by the control voltage applied to them; the smaller the magnitude of the control voltage, the higher the attenuation. This control voltage is derived by comparing, at the voltage comparator IC1c, a d.c. reference voltage from IC1d with the r.f. detector voltage from IC1b. The voltage from IC1c (TP2) controls D2, and the inverted voltage from IC1a (TP1) controls D18, D19 and D4. If the r.f. detector voltage differs from the reference voltage, the pin diodes will be driven so as to annul this difference, TR16 is off, and providing D4 is forward biased D5 will also be turned off disconnecting the l.f. channel drive.

107. The r.f. detector measures the peak voltage at the output of the fixed gain transistor pair, TR8, TR10, immediately before the 50 Ω resistor, R47. Thus the voltage can be precisely controlled behind a 50 Ω source impedance. D12, C34 form the negative-peak detector whose voltage is buffered by IC1b. D13 provides temperature compensation for the detector diode. D11, C33 act as a mimic positive-peak detector to help equalize the loading on TR10.

108. LF channel and a.l.c. The 1.f. channel is selected by a 'high' instruction on IC2, pin 9, and a 'low' on IC2, pin 5. TR16 is then turned on supplying current to the 1.f. amplifiers, whilst TR5 is turned off. The 1.f. channel input (frequencies less than 32.5 MHz) at PLDA is amplified by three transistor stages, TR11, 13, 15, operating in a 200 Ω system, and then by the common output transistor pair, TR8, TR10, operating in a 50 Ω system. The transfer from 200 to 50 Ω is accomplished with a consequential signal loss of 12 dB, this is however compensated for by the ample gain in the amplifier chain. When the 1.f. channel is on, D5 is forward biased and D4 reverse biased allowing signals to be routed from TR15 to TR8.

109. LF channel levelling is implemented by making the first two amplifiers variable-gain stages. JFET's are used in the emitter circuits of TR11 and TR13 for this purpose. The drain-source resistance of the f.e.t's and hence the gain of each stage, is controlled by the control voltage on TP1; the more negative this voltage is, the lower the gain. The control voltage is derived in the same way as for the h.f. channel, except that because TR16 is on, the voltage on TP1 is offset by -7.5 V (due to R69).

110. ALC reference voltage. The d.c. reference voltage to the comparator IC1c is the means through which accurate control of the output r.f. signal level is obtained. The actual d.c. voltage required for any given frequency and output level is influenced by a number of different circumstances. Further complications are present when amplitude modulation (a.m.) is applied which are compensated for by the circuits described below.

## Electronic fine attenuator

111. AT0 attenuator unit provides the coarse attenuation of the output signal from AC4 in multiple steps of 10 dB. An electronic attenuator on AC4 is used to give fine control of the output over a range of 10 dB, with a resolution of 1 mV (r.m.s., p.d.). This is achieved by supplying an accurate d.c. reference voltage to the a.l.c. comparator IC1c.

112. In the normal mode AC4 is required to give an output between 158 mV and 500 mV, rising to 1000 mV in the +6 dB mode. For a maximum figure of 1000 and a resolution of 1 a 10 bit binary number is needed i.e. 1000 decimal = 1111101000 binary. This requirement is implemented in IC6, IC3d where IC6 is the 10 bit digital-to-analogue (D/A) converter to which the binary number is sent. The D/A has its own internal data latches.

113. The least significant digits are sent first to address A7L2, followed by the 2 most significant digits to A7L3. The number in the D/A determines the gain of IC3d, and hence the output on pin 14 in relation to the input on IC6, pin 3. A change of 1 in the 10-bit number will give rise to a voltage change from IC3d which in turn causes a change in the reference voltage applied to the comparator. When calibrated this will change the output level from AC4 by 1 mV. In calibration the voltage on IC6, pin 3 is set to give a certain r.f. output; R89 is used to calibrate the fine attenuator across its working range. (The purpose of D16, IC1c etc. is explained under a.m. processing.)

Insertion loss control (i.l.c.)

114. After the point at which levelling occurs, (TR10 collector) the r.f. signal is subject to the insertion loss of coaxial cables, connectors, AT0 coarse attenuator, etc. before the output socket. The insertion loss is frequency dependent, and becomes more pronounced the higher the frequency. To compensate for this AC4 output is increased by an amount equal to the insertion loss at the selected frequency. This is achieved by adding a small offset to the reference voltage applied to the a.l.c. comparator. Clearly the amount of offset needed will increase with frequency.

115. This is achieved by IC4 8 bit D/A converter, to which the microprocessor sends a number (address A7L1) representing the correction required. At low frequencies where insertion loss is low, the number sent to the D/A gives IC3b a gain close to -1, and the output on IC3c, pin 8 will have a certain value (depending on the setting of R86). As the frequency is increased the number sent to the D/A reduces the gain towards 0 and consequently the output from IC3c increases in magnitude. This increase in voltage at the input to the fine attenuator is amplified according to the r.f. output level required and fed to the a.l.c. comparator to bring about the insertion loss compensation.

116. The number sent out to IC4 is calculated by the microprocessor from data stored in its memory. A sufficiently accurate approximation to the real insertion loss is obtained using just three calibration frequencies 10, 520 and 1040 MHz. At 10 MHz a code number 050 is stored (using Second function 6) and R86 adjusted for the correct r.f. output level. The frequency is then set to 520 MHz and the stored code number increased until the level is again correct. Finally the process is repeated at 1040 MHz (2019 only). When a carrier frequency is selected the microprocessor calculates the required code number from a straight line graph drawn between neighbouring calibration points. The actual binary number sent to the D/A is 255.

AM processing

117. The r.f. detector D12, C34 measures the peak voltage of the r.f. signal. When a.m. is present the detector measures the peak of the a.m. envelope; at 100% depth this will be double the voltage at 0% depth. To ensure that the r.f. level is still correct the reference voltage applied to the comparator must be increased by an amount equal to the detector voltage increase due to the a.m. If this is not done there will be an r.f. level error introduced depending on the a.m. depth.

118. This is overcome by adding to the d.c. reference processing chain an a.m. drive signal derived from AC5 via PLCZ, pin 11 and including a mimic detector, D16, C58. The mimic detector measures the peak voltage of the a.m. drive signal superimposed on the d.c. reference which - when calibrated - will produce the correct r.f. output level.

119. In practise the r.f. detector has a finite time constant (R45/C34) and so that changes in r.f. level can take place quickly, the time constant must not be too long. Consequently at low modulation frequencies the detector output will decay between envelope peaks at a rate depending on this time constant. In order to preserve the a.m. the reference voltage applied to the comparator must match the r.f. detector voltage exactly. If this is not done the comparator will produce a control signal that will tend to remove the a.m. from the r.f. signal. To make the reference behave in the same way as the r.f. detector voltage the mimic detector is set to have the same time

constant as the r.f. detector by means of the det. trim control R95. Temperature compensation for the mimic detector is provided with D17 (similar to D13).

120. The loop bandwidth of the a.l.c. system is approximately 50 Hz (C47/R74) so at very low modulation frequencies the comparator has appreciable gain and the a.l.c. loop acts as an envelope feedback system. This means there will be a modulation frequency signal on the comparator output which will further modulate the carrier unless the two inputs to the comparator are accurately matched. This is done by applying a calibrated a.m. input of low modulation frequency and adjusting R77, set low mod. freq. until the output from AC4 is correct.

121. For the a.m. to be correct at low modulation frequencies the audio drive level on the reference to the comparator must be exactly equal to the audio level from the r.f. detector. Setting this condition also eliminates the r.f. level error occurring at higher modulation frequencies caused by the uncalibrated peak level of the a.m. drive signal on the reference signal.

## AC5 - Amplitude modulator

*Circuit diagram : Chap. 7, Fig. 18*

122. AC5 board provides amplitude modulation of the output signal from AB2, divide-by-two chain (frequency range 2.03125-520 MHz). The modulated signal is then routed to the Filter board, AC3/AC13. AM depth from 0 to 99% is programmable in 1% steps, using seven bits of control data which are brought to the internal latch in the D/A converter, IC4, via the instrument bus. An eighth bit of data is used to activate the "+6 dB mode", in which the r.f. output level from AC5 is doubled. Under this condition no a.m. is allowed, and the microprocessor instructs 0% a.m. depth.

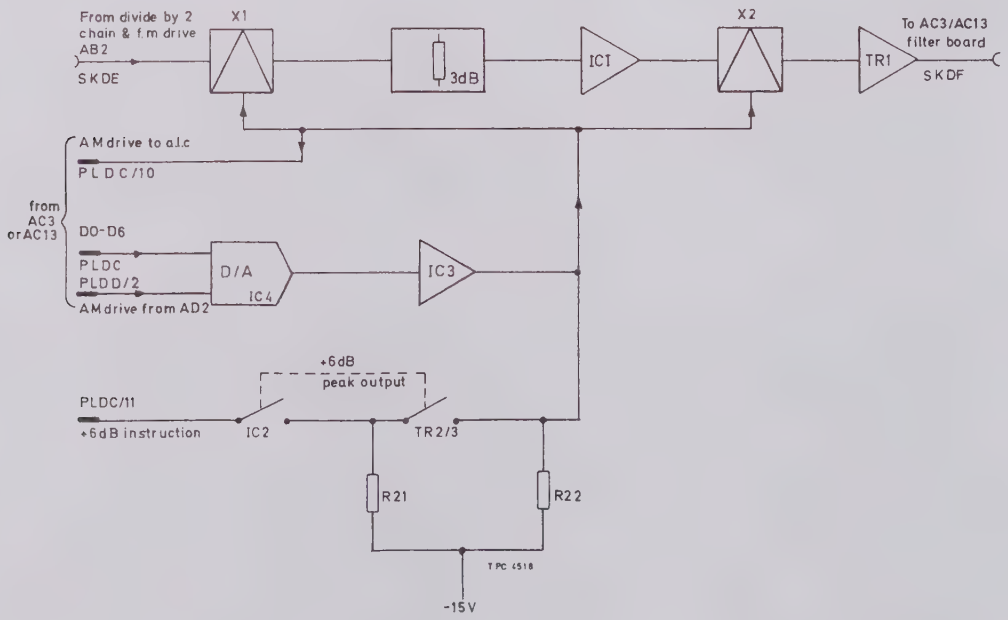



*Fig. 13 Amplitude modulator (AC5)*

123. The modulator consists of two double-balanced mixers, X1 and X2, in cascade, with a 3 dB pad (R2-R4) and a recovery amplifier, IC1, between them. X2 is responsible for the main part of the modulation, with X1 providing a lower level of pre-modulation at large envelope depths. The pre-modulator can be adjusted by varying the a.m. drive signal to X1 using preset R23. The output from X2 is amplified by TR1 and fed to SKDF.

124. The audio input is fed to the linear port of the D/A converter, IC4, from PLDD, and is amplified by IC3 whose gain depends on the control data latched into the D/A. The resulting a.m. signal is fed to X1 and X2, and also to the a.l.c. system on AC4 output amplifier via PLDC, pin 10. If the +6 dB mode line is high, TR3 is turned on thus doubling the bias current in X2. This causes an increase in the r.f. output at SKDF of 6 dB.

AD1 - Display board

*Circuit diagram : Chap. 7, Figs. 20 and 21*

125. The display board incorporates the three liquid crystal displays (l.c.d.) that are used to show the current settings of the instrument. The displays are driven using c.m.o.s. logic IC's to apply square waves to the segments of the display. Each l.c.d. has a backplane (b.p.) which is connected to the backplane drive (b.p.d.). The b.p.d. is a 50 Hz square wave.

126. The segments are driven by a similar square wave that is either in phase or out of phase with the b.p.d. If the segment drive is in phase with the b.p.d. there is no voltage applied between the segment and the backplane and the segment remains clear. If the segment drive is out of phase with the b.p.d. then a square wave voltage is applied between the segment and the b.p.d. and the segment darkens. It should be noted that d.c. voltages should not be applied to the l.c.d's since this can result in permanent damage to the display. A nominal -5 V supply for the board is generated using the Zener diode D1.

127. The backplane drive is generated by the astable multivibrator IC19. The output from IC19, pin 10 is a 50 Hz square wave switching between 0 V and +5 V. Before being applied to the displays the level of the square wave is translated to be between +5 V and -5 V at the outputs on IC18, pin 3 and IC26, pin 3.

128. Information to control the displays enters the board via PLAL. The D0 to D7 lines and the A0 to A3 logic levels are made c.m.o.s. compatible by IC1 and IC2 open collector buffers and the pull up resistors in R1. IC13, 15 and 16 decode the address lines to provide control lines to instruct the latches on the board. When the A5 line is held low the output from IC15, IC16 corresponding to the address set on A0 - A3 lines goes high (+5 V). These output lines, labelled A5L0 to A5L12, control which latch latches the data on the D0 to D7 lines.

129. With the exception of the decimal point driving system the data lines and the latch control lines are connected to the respective 4056 and 4054 l.c.d. drivers. The 4056 drivers are used to drive the seven segment displays. Each IC latches four input data lines, either D0 to D3 or D4 to D7, and decode the data to drive the seven segment display. The 4056 also level shifts the decoded information and converts it into a square wave between +5 V and -5 V suitable for driving the display. If a binary 15 instruction is latched in the display will remain blank.

130. The 4054 display drivers also latch the data line inputs when instructed but these drivers simply convert the input information into a square wave between +5 V and -5 V without decoding the data. This type of drive circuit is used to drive the annunciators on the display where one input line is required to control one annunciator.

131. In order to reduce the number of addresses and drivers required the decimal points are driven by a different system. Use is made of the fact that only one decimal point on each display is required to be set at one time. The frequency display decimal point is derived by IC14, 17 and 18. IC17 is a 1 out of 8 decoder which decodes the data lines D0 to D2 and its outputs are latched by IC14, 18. Since only one of the output lines of IC17 can be high one of the decimal points can be set. If the number decoded by IC17 is a binary 7 (i.e. D0 = 1, D1 = 1, D2 = 1) then no decimal point is set since pin 4 of IC17 is not connected. The decimal points for the modulation and r.f. level displays work in a similar manner on D3, D4 and D5, D6 lines respectively.

AD2 - Motherboard

*Circuit diagram : Chap. 7. Fig. 22*

132. The primary purpose of AD2 motherboard is to serve as a means of interconnecting the various areas of the instrument that require access to the microprocessor via the internal instrument bus. The interconnections are generally made by means of plugs on the motherboard that connect to ribbon cable and socket assemblies. The plugs on the board consist of arrays of machine inserted square wire wrap posts arranged in a dual in-line configuration. The p.c.b. AD3 is connected to the motherboard by an edge connector socket SKAH mounted on the motherboard.

133. The motherboard also latches the control data for the attenuator. IC1 is an octal latch on address A6L10 that latches the data used to control the attenuator pads and the r.p.p. reset. The outputs from IC1 are connected to the open collector driver, IC2, to directly drive the solenoids that operate the attenuator pads.

134. In order to simplify the interconnections in the lower r.f. box its data valid line, A7, is gated with the A3 line by IC3, thus saving a further line through the filter box. The resulting A3 + A7 output line goes 'low' only when both are held low, i.e., when information is being sent to addresses between A7L0 and A7L7.

AD3 - Modulation oscillator and f.m. control

*Circuit diagram : Chap. 7, Fig. 23*

135. Control information for the modulation oscillator and other analogue switches on this board are latched by IC5. The latch addresses are decoded by IC14. The Zener diode D4 generates a -7.5 V supply from the -15 V supply for use by the analogue gates on the board. This enables the analogue gates to be connected to a supply voltage of +5 V and -7.5 V.

136. The modulation oscillator is a thermistor stabilized Wien bridge oscillator. IC1a is the maintaining amplifier and R2 the thermistor. The frequency of oscillation is determined by the analogue gates IC2, IC3 and IC4 which select from a bank of resistors R3 to R11, C2 and C3 are the two frequency determining capacitors.

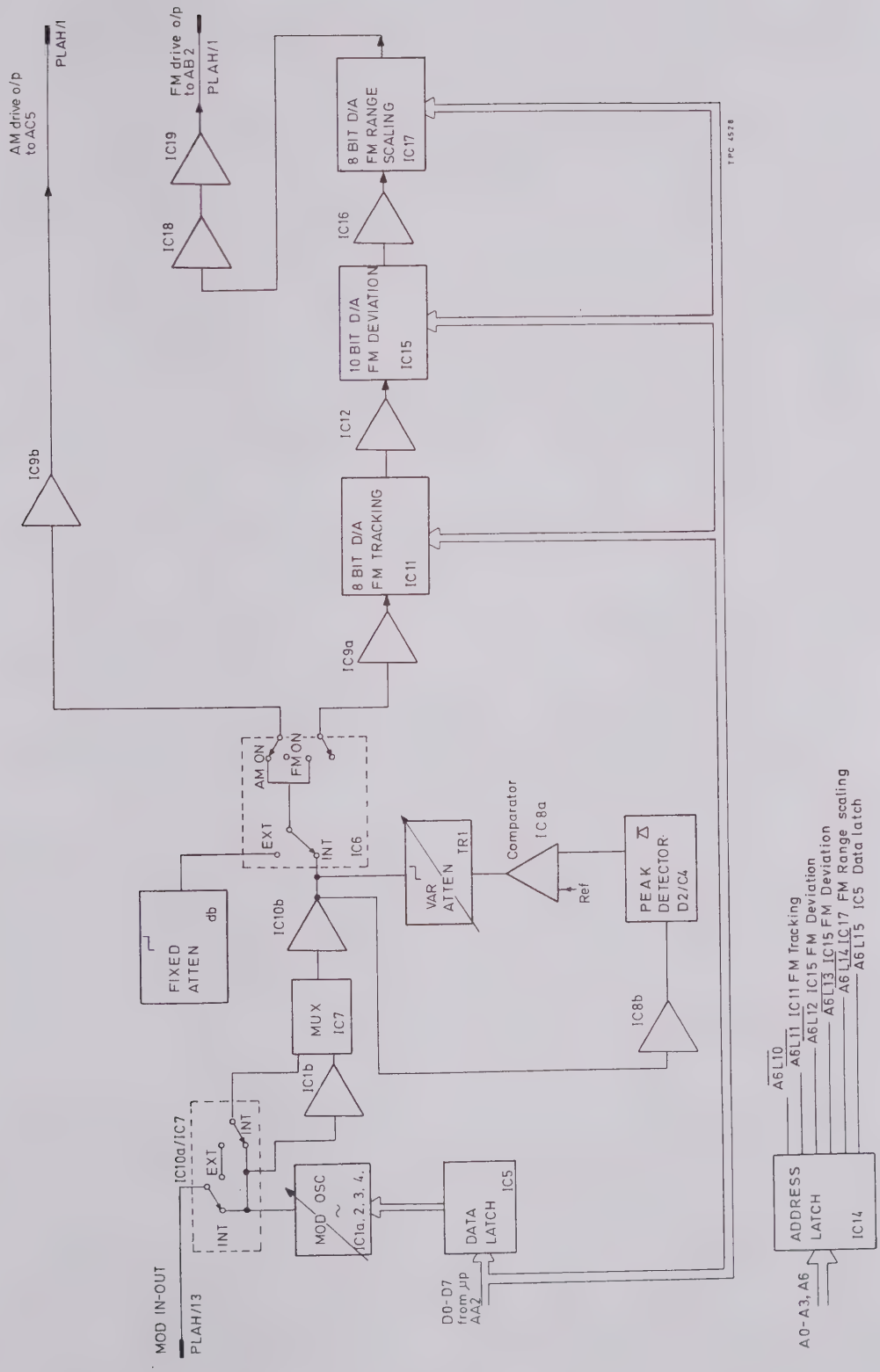



*Fig. 14 Modulation oscillator and f.m. control (AD3)*

137. If internal modulation is selected the output from IC1, pin 1 is routed via IC1b and IC7 to the modulation oscillator output line on PLAH, pin 13. A similar signal is also routed to IC10b. If external modulation is selected the modulation oscillator remains on but the modulation input signal on PLAH, pin 13 is routed to IC10b via IC7 and IC10a.

138. The output is then fed to two resistor chains. If external modulation has been selected and the modulation a.l.c. has been set to off, the output from the wiper of R16 is connected to IC6, pin 15. If the modulation a.l.c. has been set to the on condition (this is always so if internal modulation is selected) the signal on IC6, pin 1 is connected to IC6, pin 15. The signal level on pin 1 is controlled by the j.f.e.t. TR1 which is used as a voltage variable resistor. TR1 is part of an a.l.c. loop which ensures that the signal level on IC6, pin 1 is substantially independent of input level.

139. The level on IC6, pin 1 is amplified by IC8b and its level is peak detected by D2 and C4. The resulting d.c. level is compared to a reference level by IC8a and this output is used to control the variable resistor formed by TR1. The reference level on the junction of R23 and R24 is temperature compensated by D1 to offset the temperature coefficient of the detector diode, D2.

140. If amplitude modulation is on, the signal on IC6, pin 15 is routed to IC6, pin 14 and then amplified by IC9b. The resulting audio signal is connected to PLAH, pin 11 for routeing to AC5 Amplitude modulator. The variable resistor R30 is used to vary the audio drive level and is used to set the a.m. depth accuracy at 1 kHz modulation frequency.

141. If frequency modulation is on the signal is routed to IC6, pin 4 and then amplified by IC9a. The signal at IC9a output is set to a nominal 12 V p-p by R33. The signal is controlled by a series of 3 c.m.o.s. D/A converters. IC11 D/A modifies the drive signal level in accordance with the f.m. tracking data from the microprocessor. IC15 D/A controls the signal level in accordance with the f.m. deviation set and IC17 divides the signal level by factors of 2 in order to provide range scaling.

142. The data required by IC15 is a 10 bit binary number and is loaded into the D/A in two bytes. The first byte is the 8 bits corresponding to the least significant bits while the second byte is the 2 most significant bits. The setting of the D/A only changes when the most significant bits are loaded in. The output from IC18 is then amplified by IC19 and the output taken to AB2 via the motherboard AD2 and PLAH, pin 1.

## AD4 - Keyboard

*Circuit diagram : Chap. 7, Fig. 24*

143. Keyboard AD4 carries all the front panel key switches, the l.e.d. indicators for the modulation oscillator frequency and the control logic required to interface the switches and the l.e.d's to the internal data bus.

144. The key switches are arranged as an array organized in rows and columns. The latch IC4 is initially set to give logic 'low' at all its outputs. The pull up resistors in R5 set the logic levels at the inputs to IC5 to a logic 'high'. When the microprocessor is monitoring the keyboard IC5 buffer is enabled to drive the internal data bus and so the microprocessor is able to monitor the state of the keyboard. For convenience the inputs to IC5 are referred to as columns and the outputs from IC4 are referred to as rows.

145. When a key is pressed it shorts that column to one of the rows. In order to find which key in a column has been pressed the microprocessor sets all but the top row (connected to IC4, pin 2) to the high state. If the key pressed was in the top row then the column will remain in the 'low' state. If not, the column returns to the 'high' state and the microprocessor sets a 'low' to the next row down (IC4, pin 5) with all other rows set 'high'. This is repeated until the correct row is located. Having determined which row and which column the key was in this uniquely identifies the key pressed.

146. The transistors TR1 and TR2 form an electronic extension to the keyboard allowing the microprocessor to identify when the r.p.p. has operated. If the r.p.p. has been tripped TR2 is turned on by the r.p.p. active line and pulls the left-hand column to ground in the same way as the keys do. When the microprocessor scans the keyboard TR1 holds TR2 off when IC4, pin 12 is high and so the keyboard responds in the same way as if a key corresponding to that row and column had been pressed.

147. The l.e.d's in the key switches and the circle of l.e.d's indicating the modulation oscillator frequency are controlled by the latches IC2 and IC3. The resistors R1 and R2 control the current flowing in the l.e.d's.

AE1 - Power supply board

*Circuit diagram : Chap. 7, Fig. 2*

148. The mains supply range is set by two selector switches, SAR and SAS, whose position is locked by a cover plate. The mains transformer is located in a steel box underneath board AE1.

149. The power supply is required to generate regulated +24 V, +15 V, +5 V and -15V d.c. voltage lines. The +5 V supply is derived from secondary 1 of the mains transformer. This is rectified by bridge D1 of AM0 and is located on the power supply chassis under the board AE1. The rectifier bridges for the other supplies (D1, D2, D3 or AE1) are located on the board AE1 together with the reservoir capacitors C1, C6, C7 and C10.

150. The d.c. from the reservoir capacitors is regulated by three terminal adjustable regulators. The regulators for the +5 V and +15 V supplies are IC1 and IC2 of AM0 and are located on the heatsink on the rear of the instrument. The potentiometers R2, R5, R8 and R11 enable the output voltages of each supply to be adjusted. Each of the regulator's IC's is protected against accidental shorts causing high discharge currents by 1N4004 rectifier diodes. The bypass capacitors C3, C5, C8 and C11 improve the ripple rejection of the regulators. Each regulator also has an internal thermal protection circuit.

151. The board AE1 has been carefully arranged such that the earth point of the resistor chain at the output of the regulator has been terminated on the chassis by a separate route to that of the reservoir capacitors. This ensures that the outputs from the regulators are free of mains supply ripple.

AT0 - 10 dB step attenuator

*Circuit diagram : Chap. 7, Fig. 25*

152. The p.c.b. AT1 is located in a casting and the board is made of a low loss p.t.f.e. based material. Screens are added to provide signal isolation at high frequencies. The lid of the attenuator uses a compressible foam backed gasket to provide an r.f. seal between attenuator sections.

153. The board AT1 provides precision 10 dB steps in the output level and incorporates a reed relay to provide reverse power protection. Each attenuator pad consists of 3 precision chip resistors that provide attenuation of 10 dB, 20 dB or 30 dB. Each pad is switched in or out of circuit by microswitches actuated by a solenoid. When a pad is switched out the r.f. signal is connected to a direct bypass route. The insertion loss of the direct route and the pad (excluding the intended attenuation) is set up to be identical by the adjustment of small flags. These are adjusted by means of nylon screws in the screens. Each pad is separately set up and requires the use of specialist measuring facilities and it is recommended that this is carried out by the nearest Marconi Instruments agent or Marconi Instruments Service Division.

RPP - Reverse power protection

154. Resistors R16 to R20 form a high impedance r.f. signal divider at the output of the attenuator which is used to sense the r.f. present at the output of the attenuator. Diodes D1 and D2 detect the signal level and the resulting d.c. is connected for use in the r.p.p. system. If the signal level exceeds a preset limit the reed relay RLF is set to the open circuit condition in order to protect the attenuator from excessive power dissipation. The decoupling capacitors C1, C2 result in the detector being more sensitive to very low frequencies than to r.f. This ensures that it is not possible to damage the attenuator with externally applied d.c.

155. The reed relay RLF is mounted in a coaxial tube to ensure that the v.s.w.r. of the reed assembly is very low. It should be noted that the reed should be handled very carefully since it is fragile and is particularly prone to damage around the glass seals at each end. The reed is operated by the magnetic field from the inductor L1. L1 is wound on a bobbin and the reed relay, surrounded by its coaxial tube, is slid up the centre of the bobbin.

AT2 - Attenuator control

*Circuit diagram : Chap. 7, Fig. 26*

156. Board AT2 controls the attenuator pads and the r.p.p. detector system. The board is located directly above the attenuator casting. The control lines that energize the attenuator pad solenoids come onto the board via PLAE from the motherboard AD2. When one of these lines is grounded by the open collector driver on AD2, current flows through the corresponding solenoid and the solenoid armature moves across and operates the attenuator microswitch.

157. When a solenoid is energized (control line grounded) the attenuator pad is switched out of circuit. The Zener diodes D4 to D8 act as clamps to protect the open collector drivers on the motherboard. When a solenoid is de-energized the stored magnetic field causes a large voltage spike on the control lines whose amplitude is clamped by the Zener diodes.

158. The power for the solenoids is supplied by PLP, pin 1. Normally this supply is at approximately +9 V. This, by itself, is not adequate to pull in the solenoids, therefore when the microprocessor updates the attenuator setting, supply to the solenoids is temporarily increased to approximately 20 V for 50 ms. This is accomplished by the monostable IC4 and transistors TR2 and TR3. When the attenuator setting is updated by A6L10 instruction at PLV, pin 6, IC4 triggers producing a 50 ms pulse on pin 8 to turn on TR2/TR3. This effectively connects the +20 V supply to PLP, pin 1. Diode D11 prevents the two supplies from shorting together. When TR3 turns off, D11 turns back on to restore a

+9 V supply. The use of this pulsed supply reduces the power consumption of the attenuator solenoids.

159. The r.p.p. is also controlled on AT2. The output from the peak detectors used to detect the application of reverse power to the attenuator board AT1 is fed in to AT2 at PLN, pins 1, 3 and 4. IC1 detects the difference voltage between these detector outputs. The output on IC1, pin 6 is then compared with a reference on IC2.

160. If the detected signal level is excessive IC2, pin 7 is asserted 'high' resetting the R-S flip-flop formed by IC3. This results in IC3, pin 13 going 'high' turning off TR1. The voltage on PLN, pin 1 then falls to zero and the reed relay on AT1 attenuator is open circuited. The reaction time between the application of reverse power and the reed relay going open circuit is typically 80 µs. The Zener diode, D3, protects TR1 against the voltage transient when power is removed from the reed relay's operating inductor (l.e.d. D10 is on when the reed relay is closed to indicate that operation is normal).

161. When the reed relay goes open circuit the RPP ACTIVE line on PLV, pin 9 is asserted 'high'. This line is connected to the keyboard AD4 where the microprocessor detects its operation and responds accordingly. The r.p.p. is reset when the microprocessor sets the RPP RESET line on PLV, pin 12 to the 'low' state and then subsequently sets to 'high' again.

AG0 - GPIB adaptor module

*Circuit diagram : Chap. 7, Fig. 27*

162. This module is an optional item and only fitted to 2018/2019 when remote facilities are required. The module when connected to the rear panel, allows direct connection from a GPIB talker/listener device and implements the full IEEE 488 specifications (no control function).

163. IC2 (8291) GPIB talker/listener integrated circuit is connected to AA2 microprocessor via SKAK and AD2 motherboard providing both talker and listener capabilities, details of these are given in Chapter 3 of the Operating Manual. IC3a and IC8 determine the read and write address decoding cycle. IC1 operates as an independent clock whose frequency (between 1 and 2 MHz) is used to time out an approximate 2 µs delay allowing the bus to settle after sending data.

164. IC4 - IC7 transceivers are used to translate the negative true logic and act as drivers. IC3b provides the logic 'low' level for the receive instruction TR/1 to IC5, pins 7, 9; or the talker 'high' level for IC5, IC6 and IC7 and also provides the additional buffering necessary for the three IC's in line.

## SECOND FUNCTION OPERATIONS

165. Second function operations provide the means of controlling various secondary features and calibrations within the instrument. There are three levels of operation, two of which require unlocking in order to gain access. Each level of operation and method of access is described below.

166. Normal operation

Second functions '0' Unlock
'1' Status information
'2' GPIB address setting
'3' Manual latch setting

These functions are unprotected and may be accessed directly:- Press SECOND FUNCT followed by 0, 1, 2 or 3 key as required.

167. First level operation

Second functions '4' SRQ mask setting
'5' RF level units setting
'6' RF level offset
'-' RECALL STORE 10 at switch-on.

These functions have first degree protection and are accessed by the following procedure:- Press SECOND FUNCT, 0, then the MOD OSC and ON/OFF keys simultaneously, holding these down for a minimum of 5 seconds. Follow this by pressing SECOND FUNCT and the numeral 4, 5, 6 or '-' as required.

168. Second level operation

Second functions '7' RF level calibration
'8' FM calibration
'9' 2018/2019 software flag setting
'.' Calculation and storage of amended EAROM check sum

These functions have second degree protection and access to Second level operation is restricted to authorized calibration units only. Interference with these second functions could invalidate the instrument's calibration.

169. Second function '3' Manual latch setting

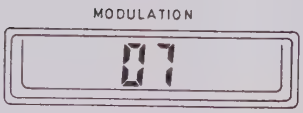
Second functions 0, 1, 2, 4, 5, 6 and '-' are fully described in Vol. 1. Operating Manual. Second function 3, Manual latch setting,allows the operator to direct an 8 bit binary instruction to any of the instrument's internal latches for testing and fault-finding. The latch is selected first by selecting the SECOND FUNCT 3 mode then entering the number of the data valid line (1 digit 4 to 7), this information is displayed in the Modulation display window. This is followed by the number of the latch (2 digits 00 to 15) and is displayed in the RF level display window. The data is then entered in binary (8 binary digits 0000 0000 to 1111 1111) and is displayed in the Carrier Frequency display window. The data is sent to the requested latch on pressing the 'STORE' key. New data may be sent without re-entering the latch address if required.

170. Further details of the control data used for individual boards is given in Chap. 5, Maintenance. The example following illustrates the procedure for setting the control data to a board such as AC5, Amplitude modulator.

To set 30% modulation on the board carry out the steps (1) to (3) as follows:-

Latch address for AC5 board is $\overline{A7L0}$

(1) Address (A7); Press the numeral 7 on the keyboard, display shows:-




(2) Latch (L0); Press the numeral 0 on the keyboard twice (L0 implies L00), display shows:-

(3) 30% Modulation; To obtain 30% modulation, set a binary 30 in the Carrier Frequency display by entering either 1's or 0's from the keyboard, numbers are rotated in from the right, display shows:-

To complete the operation press the STORE key.

171. Second function '7' RF level calibration setting

The output level is calibrated by setting a control number (0 - 255) at 10 MHz and 520 MHz (and 1040 MHz for 2019) via second function 5. At all other frequencies the required control data is calculated from these numbers. The instrument allows access to one of these numbers at a time, according to the current carrier frequency. The current value is shown in the RF level display window when second function 7 is selected: a new number may be entered via the keyboard, (or GPIB) or the displayed number changed using the UP and DOWN keys. The output level changes accordingly: to store the new number press the 'STORE' key.

172. Second function '8' FM tracking

The frequency deviation when f.m. is selected is calibrated at 84 frequencies: at other frequencies the required data is calculated internally from the adjacent tracking point data. In order to set a calibration figure at a tracking point, the generator must first be set to the required frequency, with f.m. on, in the normal way. Second function 8 will then display the current calibration number in the RF level display window. This number may be changed by entering a new number, or incremented using the UP and DOWN keys for convenient fine control: the change is effective immediately. The STORE key is used to overwrite the old number with the new: until this happens no permanent change to the calibration data is effected.

173. Should the generator be tuned to a frequency which does not correspond to a tracking point, second function 8 will display the "---" (retuning required) message.

174. Second function '9' 2018/2019 software flag setting

This software package is suitable to drive both the 2018 (520 MHz) and 2019 (1040 MHz) signal generators: second function 9 informs the microprocessor which instrument it is driving. Operation is as for alternative level calibration data selection: '1' indicates 2019; 0, 2018.

175. Second function '·' (decimal point). Calculation and storage of amended EAROM check sum. The initial operating mode of the instrument should be shown on the front panel display at switch on. This is CARRIER FREQ 520 MHz (2019, 1040 MHz) internal MOD OSC 1 kHz, no FM or AM MODULATION and minimum RF LEVEL (-127 dBm or equivalent). Before this occurs a check on the serviceability of the RAM and PROM is carried out and a check sum is also carried out on the EAROM stored data. If this is in error the instrument will be unable to take up the initial operating mode and will instead display the following error signal 'L' in the modulation window. At the same time an indication of the program mod state is also shown in the carrier frequency window. Earlier instruments, serial numbers 118401 having eight PROMs 44533-025C fitted and with a program mod state of either 01, 02, 03 or 04 do not carry the EAROM check sum capability.

176. The EAROM store carries the RF level calibration and FM tracking data. If this has been changed (as a result of recalibration) the check sum will not agree, therefore it is necessary to select Second function '·'. This operation calculates and subsequently stores the amended data for use thereafter as the valid check sum.

177. If the check sum is incorrect for reasons other than recalibration and this is considered an acceptable condition the instrument may be reset and used in the normal manner by pressing any of the front panel keys on the keyboard.

# NOTES AND CAUTIONS

## ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

### Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

### Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

### Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

### Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

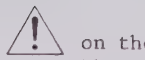
To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

## RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

*CAUTION :* STATIC SENSITIVE COMPONENTS

Components identified with the symbol  on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

*WARNING :* HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

*WARNING :* TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

Beryllia (beryllium oxide) is used in the construction of the following components in this equipment :

.....Unit AC4 : Transistor TR10.....

This material, when in the form of fine dust or vapour and inhaled into the lungs, can cause a respiratory disease. In its solid form, as used here, it can be handled quite safely although it is prudent to avoid handling conditions which promote dust formation by surface abrasion.

Because of this hazard you are advised to be very careful in removing and disposing of these components. Do not put them in the general industrial or domestic waste or despatch them by post. They must be separately and securely packed and clearly identified to show the nature of the hazard and then disposed of in a safe manner by an authorized toxic waste contractor.

Chapter 5

# MAINTENANCE

## CONTENTS

Para.
1 Introduction
11 Performance checks
11 Overall tests and adjustments
12 Frequency accuracy
13 RF output
15 Coarse attenuator functional check
17 Modulation oscillator performance
18 FM deviation
19 FM tracking
20 AM depth
22 External f.m. modulation sensitivity (ALC)
23 AM distortion
24 FM distortion
25 VSWR (5 MHz to 1 GHz)
26 Carrier harmonics and spurious signals
27 Reverse power protection
28 Fault location
28 Introduction
32 Use of second function 3
34 Maintenance kit
35 Fault finding to board level
36 Front panel failure
37 Output frequency error
40 RF level fault
45 Harmonic distortion fault
47 AM fault
49 FM fault
52 Residual f.m. problems
57 RPP failure
61 Board level fault finding
62 AA1 : LSD loop
68 AA2 : Microprocessor system
72 AA3 : Frequency standard
74 AB1 : Output v.r.d.
79 AB2 : Divide-by-two chain and f.m. drive
86 AB3 : RF oscillators
89 AB4 : Output phase detector
95 AB5 : Voltage controlled crystal oscillator (v.c.x.o) loop
98 AC2 : Beat frequency oscillator (BFO) system
100 AC3/13 : Filter and frequency doubler
109 AC4 : Output amplifier
112 AC5 : Amplitude modulator
115 AD1 : Display
117 AD2 : Motherboard
118 AD3 : Modulation oscillator and f.m. control
123 AT0 & AT1 : 10 dB step attenuator
124 AT2 : Attenuator control

CONTENTS (continued)

Para.
125 Instrument calibration
125 EAROM initialization
126 Internal frequency standard
127 RF level
128 AM calibration
129 FM calibration
130 External modulation

Table

| | | Page |
|---|---|---|
| 1 | Test equipment | 5 |
| 2 | Decibel conversion table | 7 |
| 3 | dBµV conversion table | 9 |
| 4 | ATO attenuator function check | 12 |
| 5 | Front panel failure | 21 |
| 6 | Output frequency error | 22 |
| 7 | RF level fault | 25 |
| 8 | AM fault | 26 |
| 9 | Typical f.m. tracking data | 28 |
| 10 | FM fault | 29/30 |
| 11 | Control data AA1 | 33 |
| 12 | Control data AA3 | 35 |
| 13 | Control data AB1 | 36 |
| 14 | Divide-by-two control data AB2 | 37 |
| 15 | Range control data AB2 | 38 |
| 16 | IC2 control data AC3/13 | 44 |
| 17 | IC6 control data AC13 | 44 |
| 18 | DC voltages on IC4 outputs AC3/13 | 45 |
| 19 | LF low-pass filter alignment (1-32 MHz) AC3 | 46 |
| 20 | HF low-pass filter alignment (46-520 MHz) AC13 | 47 |
| 21 | Frequency doubler AC13 | 47 |
| 22 | Control data AD1 | 50 |
| 23 | 10 dB step attenuator control data AD2 | 51 |
| 24 | Mod. osc. control data AD3 | 52 |
| 25 | FM deviation control data AD3 | 52 |
| 26 | Voltages on PLP, AT2 | 55 |

Fig.

| | | Page |
|---|---|---|
| 1a | Board location, access and pre-set adjustments | 9 |
| 1b | Location of components, connectors, plugs and sockets | 10 |
| 2 | Test gear attangement for r.f. output measurements | 11 |
| 3 | Modulation depth measurement | 14 |
| 4 | Test gear arrangement for the checking of external modulation sensitivity | 14 |
| 5 | Test gear arrangement for checking f.m. and a.m. distortion | 15 |
| 6 | Test gear arrangement to check v.s.w.r. | 16 |

Annex
A Measurement of phase noise in signal generators

## INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order, checking overall performance, fault finding and realignment procedures. Before attempting any maintenance on the equipment you are advised to read the preceding chapter containing the technical description.

2. Test procedures described in this chapter may be simplified and of restricted range compared with those that relate to the generally more comprehensive factory test facilities, which are necessary to demonstrate complete compliance with the specifications.

3. Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted in the performance data in Chap. 1. When making tests to verify that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.

4. In case of difficulties which cannot be resolved with the aid of this book, please contact our Service Division at the address given inside the rear cover, or your nearest Marconi Instruments representative. Always quote the type and serial number found on the data plate at the rear of the instrument.

5. Integrated circuit and semiconductor devices are used throughout this instrument and, although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reverse polarity and excessive heat or radiation and the use of insulation testers.

6. Numerous chip capacitors and resistors are fitted in this equipment. These have silver palladium end cap terminations. When soldering these devices the following precautions should be observed.

(i) Use solder containing 2% silver, and a temperature controlled 45 watt soldering iron set to 315°C (600°F). The use of a high wattage soldering iron will minimize the time taken to solder the device.

(ii) When soldering chip components to printed circuit boards a long fillet of solder should be laid on the track leading up to each end cap termination. This reduces the otherwise adverse inductive effects at high frequencies.

7. Static sensitive components. ⚠ The c.m.o.s. integrated circuits used in this instrument have extremely high input resistance and can be damaged by accumulation of static charges (see preliminary pages, Notes and Cautions). Boards that have such integrated circuits all carry warning notices against damage by static discharge.

8. Beryllia health hazard. This material is used in the construction of transistor TR10 in Unit AC4. Warning notices are displayed and extreme care must be exercised when wishing to disturb this transistor (see preliminary pages, Notes and Cautions).

9. Bulkhead connectors and gaskets. Special care should be taken to ensure that no r.f. leakage occurs. To this end all bulkhead connectors and lid sealing gaskets should be secure. It is essential that the unit lids be correctly relocated in their slotted recesses after removal.

10. Fault location. Some aid to fault finding is provided by the typical d.c. voltage and signal levels. Tables given are not extensive but are intended as a pointer to further investigation. It is emphasized that each fault table should be studied having regard for the others, since incorrect operation of a circuit may be caused by malfunction of an associated circuit.

## PERFORMANCE CHECKS

### Overall tests and adjustments

11. Many of the tests described in this chapter are simplified and of restricted range compared with those which would demonstrate compliance with the specification as described in paras. 1 to 4. If the results quoted in the following paragraphs are not obtainable refer to the related fault finding section and tables, and after repair ensure that realignment is carried out in accordance with that section, if applicable.

### Frequency accuracy

Test equipment : items d, Digital frequency meter
n, Standard frequency source (10 MHz)

12. (1) Connect the frequency meter to the output of the instrument.

(2) It is advisable to synchronize the frequency meter with an external standard frequency accuracy 2 parts in $10^8$ if possible.

(3) With the 2018 in any mode of operation and the INT standard selected carry out spot checks throughout the range of the instrument and ensure that frequencies are within specifications.

(4) Check that the output from the rear panel STD FREQ IN-OUT socket is a nominal 3 V p-p frequency signal at 10 MHz ±1 Hz. The standard frequency trim R1 can be accessed through the upper right-hand side outer cover and enables the internal standard to be set against a primary external standard.

*CAUTION.* ⚠

Incorrect adjustment of this preset will impair the frequency accuracy of the generator. Allow at least 10 minutes warm-up and switch the frequency counter to Select 'B' 1 Hz resolution. Adjust R1 for a reading of 10 MHz ±1 Hz then switch the frequency counter to 0.1 Hz resolution and check that the indication is the same after five counter gates.

*TABLE 1 TEST EQUIPMENT*

| *Item* | *Description* | *Minimum use specifications* | *Recommended model* |
|---|---|---|---|
| a | RF electronic millivoltmeter | Voltage range: 1mV to 3V r.m.s.<br>Frequency range: 50kHz to 520MHz (2018), 1040MHz (2019).<br>Accuracy: ±5% of f.s.d. up to 50MHz<br>±2dB up to 900MHz,<br>±3dB up to 1500MHz (using coaxial 'T' connector TM 7948). | TF 2603 |
| b | T connector | VSWR ≯ 1.2:1 at 1500MHz, terminated in 50Ω. | TM 7948 |
| c | N type 50Ω load | VSWR ≯ 1.05:1 up to 1500MHz. | TM 7967 |
| d | Digital frequency meter | Frequency range: 10Hz to 2GHz.<br>Sensitivity: 56mV r.m.s. p.d. into 50Ω.<br>Input impedance: LF 1MHz in parallel with less than 25pF.<br>Nominal 50Ω. | 2435 |
| e | Multimeter | Greater than 20kΩ/V. | GEC Selectest |
| f | Power meter & tft power head | Power range measurement: 0.03µW to 3W.<br>Accuracy: 1% of f.s.d.<br>Frequency range: 10MHz to 520MHz (2018), 1040MHz (2019) depending on the tft power head in use. | 6460 |
| g | Distortion factor meter | Fundamental range: 20Hz to 20kHz.<br>Fundamental rejection: 80dB.<br>Measurement accuracy: ±2% of full-scale<br>±2% of reading. | TF 2331A |
| h | AM/FM modulation meter with crystal osc. | FM frequency range: 4 to 1200MHz.<br>Deviation range: 1.5 to 500kHz.<br>AM frequency range: 4 to 400MHz.<br>Modulation depth range: 30 & 100%.<br>RF input frequency range: 4MHz to 1200MHz.<br>Calibration accuracy: ±3%. | TF 2300B & TK 2302 |
| i | AF oscillator | Frequency range: 10Hz to 110kHz<br>Accuracy: ±3% of reading.<br>Distortion: Better than -100dB from 10Hz to 30kHz.<br>Level: 0 to 3V. | TF 2104 |
| j | Digital voltmeter | DC volts. Ranges: ±10mV to ±1000V.<br>Resolution: 0.01% of range (10µV on 100mV range).<br>Accuracy: ±100mV range ±(0.05% of input +0.02% of range).<br>±1V to 1000V range ±(0.02% of input +0.01% of range). | |
| k | (i) Spectrum analyser<br>(ii) Frequency extender<br>(iii) Zero loss probe | Frequency range: 10kHz to 1.25GHz<br>Variable persistance/storage display | TF 2370/TK 2373 & TK 2374 |

*TABLE 1 TEST EQUIPMENT (continued)*

| *Item* | *Description* | *Minimum use specifications* | *Recommended model* |
|---|---|---|---|
| l | AF voltmeter | Range: 1mV to 100V f.s.d.<br>Frequency range: 10Hz to 10MHz.<br>Accuracy: ±1%. | TF 2600B |
| m | Oscilloscope with dual trace capability | Bandwidth: 50MΩ.<br>Volts/division: 5mV to 20V. | TELEQUIPMENT D83 with V4 dual channel wide band amp. plug-in. |
| n | Standard frequency source (10MHz) | Output level: 4V p-p.<br>Frequency accuracy: 2 parts in $10^8$. | Rubidium or Caesium reference unit |
| o | Variable d.c. power supply | 0 to 30V d.c. at 1A. | TF 2155/1 |
| p | Sweep oscillator & RF plug-in unit | Frequency range: 5MHz to 2GHz.<br>Sweep output: +2V to +10V.<br>Markers, amplitude -5V<br>F1-F2 symmetrical sweep. | 6700B/6730A |
| q | Rho-bridge with two standard 50Ω loads and calibrated mismatched loads | Frequency range: 1MHz to 1GHz.<br>Residual v.s.w.r.: ⩽ 1.01:1 from 5MHz to 1GHz.<br>Characteristic impedance: 50Ω.<br>Calibrated mismatched loads: 1.2:1, 1.5:1.<br>Two standard 50Ω loads, v.s.w.r. better than 1.02:1 from 1MHz to 1GHz. | |

*TABLE 2 DECIBEL CONVERSION TABLE*

| Ratio Down | | | Ratio Up | |
|---|---|---|---|---|
| VOLTAGE | POWER | DECIBELS | VOLTAGE | POWER |
| 1·0 | 1·0 | **0** | 1·0 | 1·0 |
| ·9886 | ·9772 | **·1** | 1·012 | 1·023 |
| ·9772 | ·9550 | **·2** | 1·023 | 1·047 |
| ·9661 | ·9333 | **·3** | 1·035 | 1·072 |
| ·9550 | ·9120 | **·4** | 1·047 | 1·096 |
| ·9441 | ·8913 | **·5** | 1·059 | 1·122 |
| ·9333 | ·8710 | **·6** | 1·072 | 1·148 |
| ·9226 | ·8511 | **·7** | 1·084 | 1·175 |
| ·9120 | ·8318 | **·8** | 1·096 | 1·202 |
| ·9016 | ·8128 | **·9** | 1·109 | 1·230 |
| ·8913 | ·7943 | **1·0** | 1·122 | 1·259 |
| ·8710 | ·7586 | **1·2** | 1·148 | 1·318 |
| ·8511 | ·7244 | **1·4** | 1·175 | 1·380 |
| ·8318 | ·6918 | **1·6** | 1·202 | 1·445 |
| ·8128 | ·6607 | **1·8** | 1·230 | 1·514 |
| ·7943 | ·6310 | **2·0** | 1·259 | 1·585 |
| ·7762 | ·6026 | **2·2** | 1·288 | 1·660 |
| ·7586 | ·5754 | **2·4** | 1·318 | 1·738 |
| ·7413 | ·5495 | **2·6** | 1·349 | 1·820 |
| ·7244 | ·5248 | **2·8** | 1·380 | 1·905 |
| ·7079 | ·5012 | **3·0** | 1·413 | 1·995 |
| ·6683 | ·4467 | **3·5** | 1·496 | 2·239 |
| ·6310 | ·3981 | **4·0** | 1·585 | 2·512 |
| ·5957 | ·3548 | **4·5** | 1·679 | 2·818 |
| ·5623 | ·3162 | **5·0** | 1·778 | 3·162 |
| ·5309 | ·2818 | **5·5** | 1·884 | 3·548 |
| ·5012 | ·2512 | **6** | 1·995 | 3·981 |
| ·4467 | ·1995 | **7** | 2·239 | 5·012 |
| ·3981 | ·1585 | **8** | 2·512 | 6·310 |
| ·3548 | ·1259 | **9** | 2·818 | 7·943 |
| ·3162 | ·1000 | **10** | 3·162 | 10·000 |
| ·2818 | ·07943 | **11** | 3·548 | 12·59 |
| ·2512 | ·06310 | **12** | 3·981 | 15·85 |
| ·2239 | ·05012 | **13** | 4·467 | 19·95 |
| ·1995 | ·03981 | **14** | 5·012 | 25·12 |
| ·1778 | ·03162 | **15** | 5·623 | 31·62 |

*TABLE 2 · DECIBEL CONVERSION TABLE (continued)*

| Ratio Down | | | Ratio Up | |
|---|---|---|---|---|
| VOLTAGE | POWER | DECIBELS | VOLTAGE | POWER |
| ·1585 | ·02512 | **16** | 6·310 | 39·81 |
| ·1413 | ·01995 | **17** | 7·079 | 50·12 |
| ·1259 | ·01585 | **18** | 7·943 | 63·10 |
| ·1122 | ·01259 | **19** | 8·913 | 79·43 |
| ·1000 | ·01000 | **20** | 10·000 | 100·00 |
| ·07943 | $6{\cdot}310 \times 10^{-3}$ | **22** | 12·59 | 158·5 |
| ·06310 | $3{\cdot}981 \times 10^{-3}$ | **24** | 15·85 | 251·2 |
| ·05012 | $2{\cdot}512 \times 10^{-3}$ | **26** | 19·95 | 398·1 |
| ·03981 | $1{\cdot}585 \times 10^{-3}$ | **28** | 25 12 | 631 0 |
| ·03162 | $1{\cdot}000 \times 10^{-3}$ | **30** | 31·62 | 1,000 |
| ·02512 | $6{\cdot}310 \times 10^{-4}$ | **32** | 39·81 | $1{\cdot}585 \times 10^{3}$ |
| ·01995 | $3{\cdot}981 \times 10^{-4}$ | **34** | 50·12 | $2{\cdot}512 \times 10^{3}$ |
| ·01585 | $2{\cdot}512 \times 10^{-4}$ | **36** | 63·10 | $3{\cdot}981 \times 10^{3}$ |
| ·01259 | $1\ 585 \times 10^{-4}$ | **38** | 79·43 | $6{\cdot}310 \times 10^{3}$ |
| ·01000 | $1{\cdot}000 \times 10^{-4}$ | **40** | 100·00 | $1{\cdot}000 \times 10^{4}$ |
| $7{\cdot}943 \times 10^{-3}$ | $6{\cdot}310 \times 10^{-5}$ | **42** | 125·9 | $1{\cdot}585 \times 10^{4}$ |
| $6{\cdot}310 \times 10^{-3}$ | $3\ 981 \times 10^{-5}$ | **44** | 158·5 | $2\ 512 \times 10^{4}$ |
| $5{\cdot}012 \times 10^{-3}$ | $2{\cdot}512 \times 10^{-5}$ | **46** | 199·5 | $3{\cdot}981 \times 10^{4}$ |
| $3\ 981 \times 10^{-3}$ | $1{\cdot}585 \times 10^{-5}$ | **48** | 251·2 | $6{\cdot}310 \times 10^{4}$ |
| $3{\cdot}162 \times 10^{-3}$ | $1{\cdot}000 \times 10^{-5}$ | **50** | 316·2 | $1{\cdot}000 \times 10^{5}$ |
| $2{\cdot}512 \times 10^{-3}$ | $6{\cdot}310 \times 10^{-6}$ | **52** | 398·1 | $1{\cdot}585 \times 10^{5}$ |
| $1{\cdot}995 \times 10^{-3}$ | $3{\cdot}981 \times 10^{-6}$ | **54** | 501·2 | $2{\cdot}512 \times 10^{5}$ |
| $1{\cdot}585 \times 10^{-3}$ | $2{\cdot}512 \times 10^{-6}$ | **56** | 631·0 | $3{\cdot}981 \times 10^{5}$ |
| $1{\cdot}259 \times 10^{-3}$ | $1{\cdot}585 \times 10^{-6}$ | **58** | 794·3 | $6{\cdot}310 \times 10^{5}$ |
| $1{\cdot}000 \times 10^{-3}$ | $1{\cdot}000 \times 10^{-6}$ | **60** | 1,000 | $1{\cdot}000 \times 10^{6}$ |
| $5{\cdot}623 \times 10^{-4}$ | $3{\cdot}162 \times 10^{-7}$ | **65** | $1{\cdot}778 \times 10^{3}$ | $3{\cdot}162 \times 10^{6}$ |
| $3{\cdot}162 \times 10^{-4}$ | $1{\cdot}000 \times 10^{-7}$ | **70** | $3{\cdot}162 \times 10^{3}$ | $1{\cdot}000 \times 10^{7}$ |
| $1{\cdot}778 \times 10^{-4}$ | $3{\cdot}162 \times 10^{-8}$ | **75** | $5{\cdot}623 \times 10^{3}$ | $3{\cdot}162 \times 10^{7}$ |
| $1{\cdot}000 \times 10^{-4}$ | $1{\cdot}000 \times 10^{-8}$ | **80** | $1{\cdot}000 \times 10^{4}$ | $1{\cdot}000 \times 10^{8}$ |
| $5{\cdot}623 \times 10^{-5}$ | $3{\cdot}162 \times 10^{-9}$ | **85** | $1{\cdot}778 \times 10^{4}$ | $3{\cdot}162 \times 10^{8}$ |
| $3{\cdot}162 \times 10^{-5}$ | $1{\cdot}000 \times 10^{-9}$ | **90** | $3{\cdot}162 \times 10^{4}$ | $1{\cdot}000 \times 10^{9}$ |
| $1{\cdot}000 \times 10^{-5}$ | $1{\cdot}000 \times 10^{-10}$ | **100** | $1{\cdot}000 \times 10^{5}$ | $1{\cdot}000 \times 10^{10}$ |
| $3{\cdot}162 \times 10^{-6}$ | $1{\cdot}000 \times 10^{-11}$ | **110** | $3{\cdot}162 \times 10^{5}$ | $1{\cdot}000 \times 10^{11}$ |
| $1{\cdot}000 \times 10^{-6}$ | $1{\cdot}000 \times 10^{-12}$ | **120** | $1{\cdot}000 \times 10^{6}$ | $1{\cdot}000 \times 10^{12}$ |
| $3{\cdot}162 \times 10^{-7}$ | $1{\cdot}000 \times 10^{-13}$ | **130** | $3\ 162 \times 10^{6}$ | $1{\cdot}000 \times 10^{13}$ |
| $1{\cdot}000 \times 10^{-7}$ | $1{\cdot}000 \times 10^{-14}$ | **140** | $1{\cdot}000 \times 10^{7}$ | $1{\cdot}000 \times 10^{14}$ |

## TABLE 3 dBμV CONVERSION TABLE

| dBm | EMF (r.m.s.) | dBμV (e.m.f.) | dBm | EMF (r.m.s.) | dBμV (e.m.f.) | dBm | EMF (r.m.s.) | dBμV (e.m.f.) |
|---|---|---|---|---|---|---|---|---|
| -130 | .141μV | -17 | -80 | 44.7μV | +33 | -30 | 14.1mV | +83 |
| -129 | .159 | -16 | -79 | 50.2 | +34 | -29 | 15.9 | +84 |
| -128 | .178 | -15 | -78 | 56.3 | +35 | -28 | 17.8 | +85 |
| -127 | .200 | -14 | -77 | 63.2 | +36 | -27 | 20.0 | +86 |
| -126 | .224 | -13 | -76 | 70.9 | +37 | -26 | 22.4 | +87 |
| -125 | .251 | -12 | -75 | 79.5 | +38 | -25 | 25.1 | +88 |
| -124 | .282 | -11 | -74 | 89.2 | +39 | -24 | 28.2 | +89 |
| -123 | .317 | -10 | -73 | 100 | +40 | -23 | 31.7 | +90 |
| -122 | .355 | -9 | -72 | 112 | +41 | -22 | 35.5 | +91 |
| -121 | .399 | -8 | -71 | 126 | +42 | -21 | 39.9 | +92 |
| -120 | .447 | -7 | -70 | 141 | +43 | -20 | 44.7 | +93 |
| -119 | .502 | -6 | -69 | 159 | +44 | -19 | 50.2 | +94 |
| -118 | .563 | -5 | -68 | 178 | +45 | -18 | 56.3 | +95 |
| -117 | .632 | -4 | -67 | 200 | +46 | -17 | 63.2 | +96 |
| -116 | .700 | -3 | -66 | 224 | +47 | -16 | 70.9 | +97 |
| -115 | .795 | -2 | -65 | 251 | +48 | -15 | 79.5 | +98 |
| -114 | .892 | -1 | -64 | 282 | +49 | -14 | 89.2 | +99 |
| -113 | 1.00 | 0 | -63 | 317 | +50 | -13 | 100 | +100 |
| -112 | 1.12 | +1 | -62 | 355 | +51 | -12 | 112 | +101 |
| -111 | 1.20 | +2 | -61 | 399 | +52 | -11 | 126 | +102 |
| -110 | 1.41 | +3 | -60 | 447 | +53 | -10 | 141 | +103 |
| -109 | 1.59 | +4 | -59 | 502 | +54 | -9 | 159 | +104 |
| -108 | 1.78 | +5 | -58 | 563 | +55 | -8 | 178 | +105 |
| -107 | 2.00 | +6 | -57 | 632 | +56 | -7 | 200 | +106 |
| -106 | 2.24 | +7 | -56 | 709 | +57 | -6 | 224 | +107 |
| -105 | 2.51 | +8 | -55 | 795 | +58 | -5 | 251 | +108 |
| -104 | 2.82 | +9 | -54 | 892 | +59 | -4 | 282 | +109 |
| -103 | 3.17 | +10 | -53 | 1.00mV | +60 | -3 | 317 | +110 |
| -102 | 3.55 | +11 | -52 | 1.12 | +61 | -2 | 355 | +111 |
| -101 | 3.99 | +12 | -51 | 1.26 | +62 | -1 | 399 | +112 |
| -100 | 4.47 | +13 | -50 | 1.41 | +63 | 0 | 447 | +113 |
| -99 | 5.02 | +14 | -49 | 1.59 | +64 | +1 | 502 | +114 |
| -98 | 5.63 | +15 | -48 | 1.78 | +65 | +2 | 563 | +115 |
| -97 | 6.32 | +16 | -47 | 2.00 | +66 | +3 | 632 | +116 |
| -96 | 7.09 | +17 | -46 | 2.24 | +67 | +4 | 709 | +117 |
| -95 | 7.95 | +18 | -45 | 2.51 | +68 | +5 | 795 | +118 |
| -94 | 8.92 | +19 | -44 | 2.82 | +69 | +6 | 892 | +119 |
| -93 | 10.0 | +20 | -43 | 3.17 | +70 | +7 | 1.00V | +120 |
| -92 | 11.2 | +21 | -42 | 3.55 | +71 | +8 | 1.12 | +121 |
| -91 | 12.6 | +22 | -41 | 3.99 | +72 | +9 | 1.26 | +122 |
| -90 | 14.1 | +23 | -40 | 4.47 | +73 | +10 | 1.41 | +123 |
| -89 | 15.9 | +24 | -39 | 5.02 | +74 | +11 | 1.59 | +124 |
| -88 | 17.8 | +25 | -38 | 5.63 | +75 | +12 | 1.78 | +125 |
| -87 | 20.0 | +26 | -37 | 6.32 | +76 | +13 | 2.00 | +126 |
| -86 | 22.4 | +27 | -36 | 7.09 | +77 | +14 | 2.24 | +127 |
| -85 | 25.1 | +28 | -35 | 7.95 | +78 | +15 | 2.51 | +128 |
| -84 | 28.2 | +29 | -34 | 8.92 | +79 | +16 | 2.82 | +129 |
| -83 | 31.7 | +30 | -33 | 10.0 | +80 | +17 | 3.17 | +130 |
| -82 | 35.5 | +31 | -32 | 11.2 | +81 | +18 | 3.55 | +131 |
| -81 | 39.9 | +32 | -31 | 12.6 | +82 | +19 | 3.99 | +132 |
| | | | | | | +20 | 4.47 | +133 |

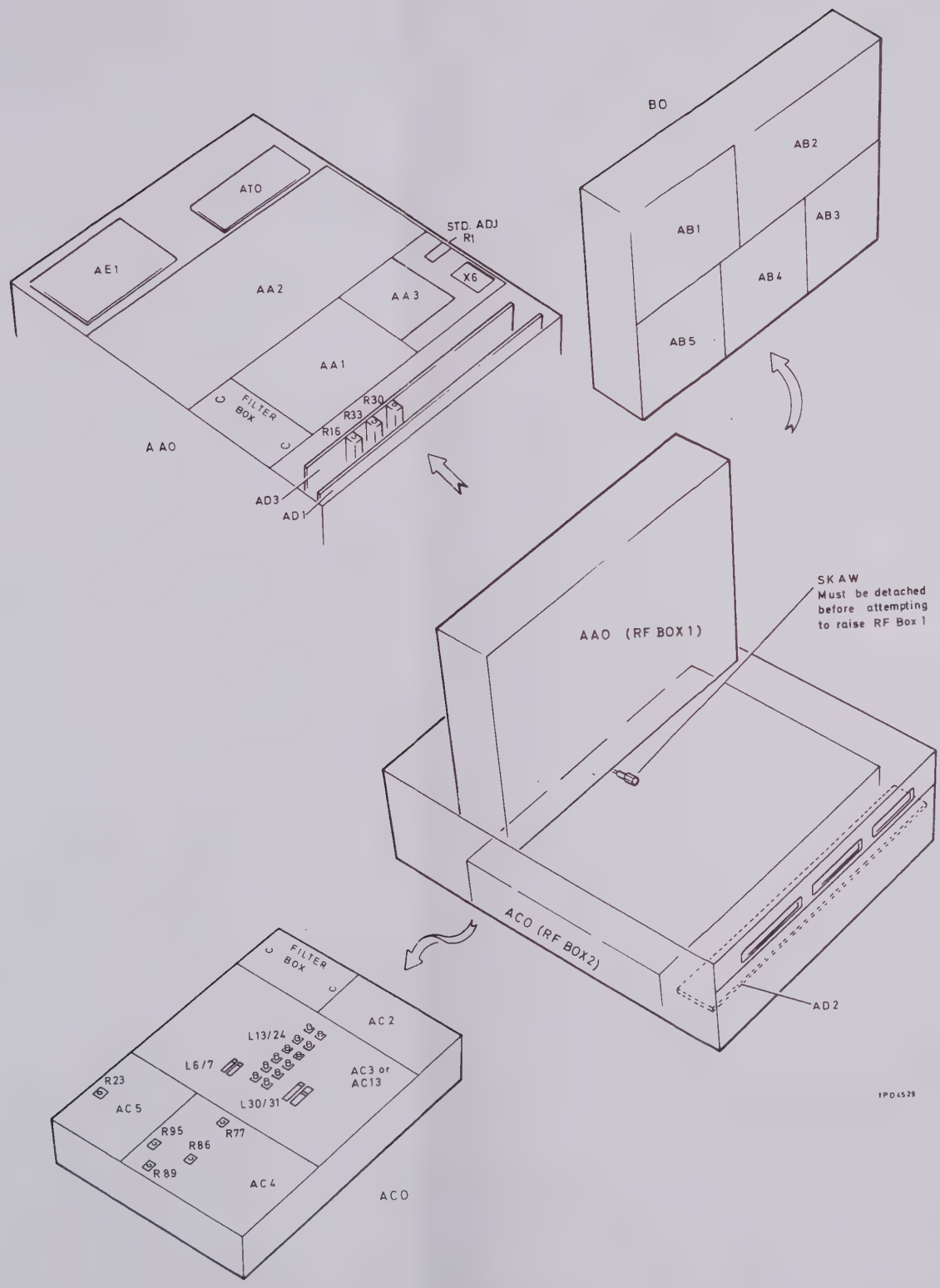



*Fig. 1a Board location, access and pre-set adjustments*

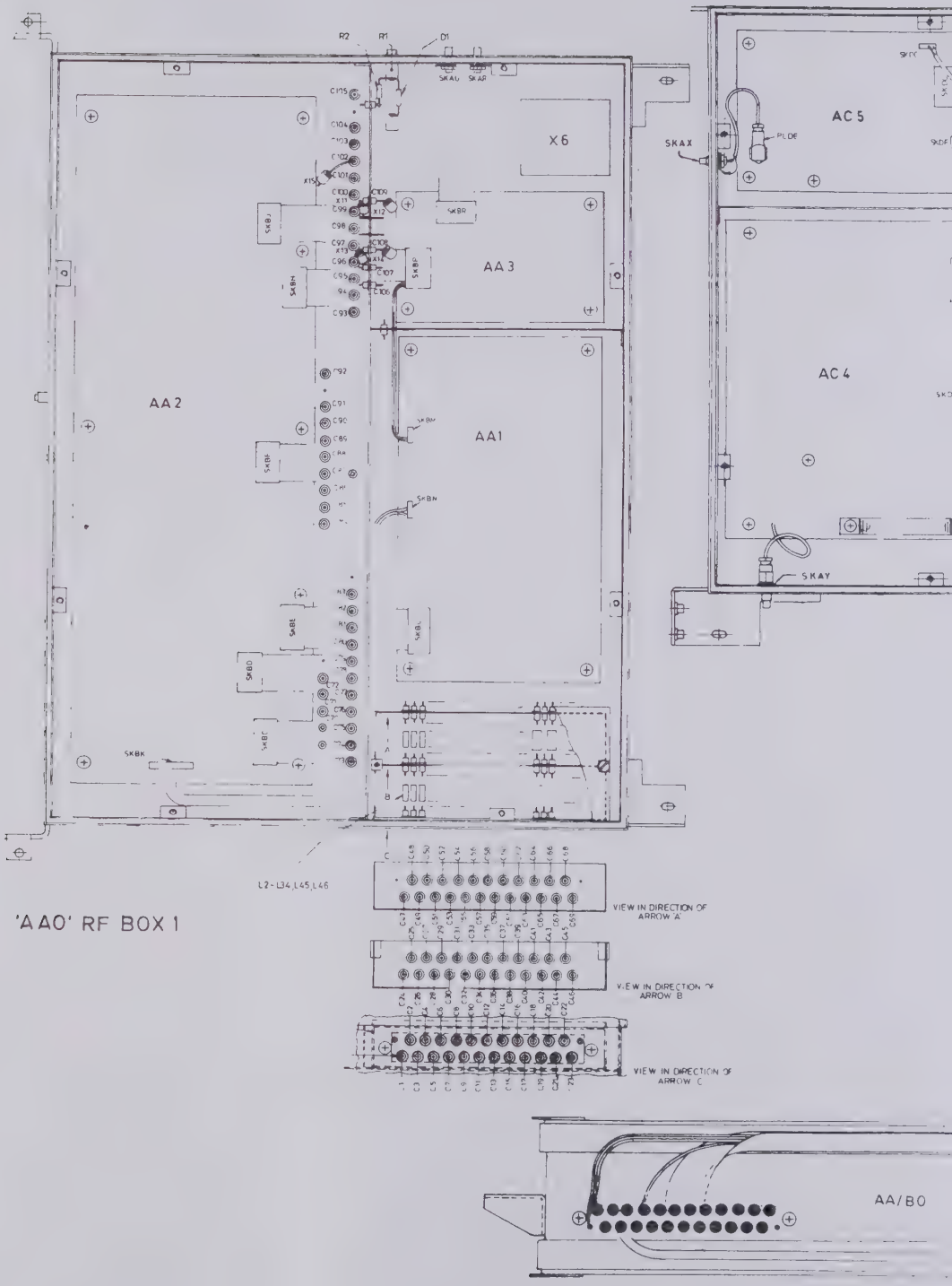
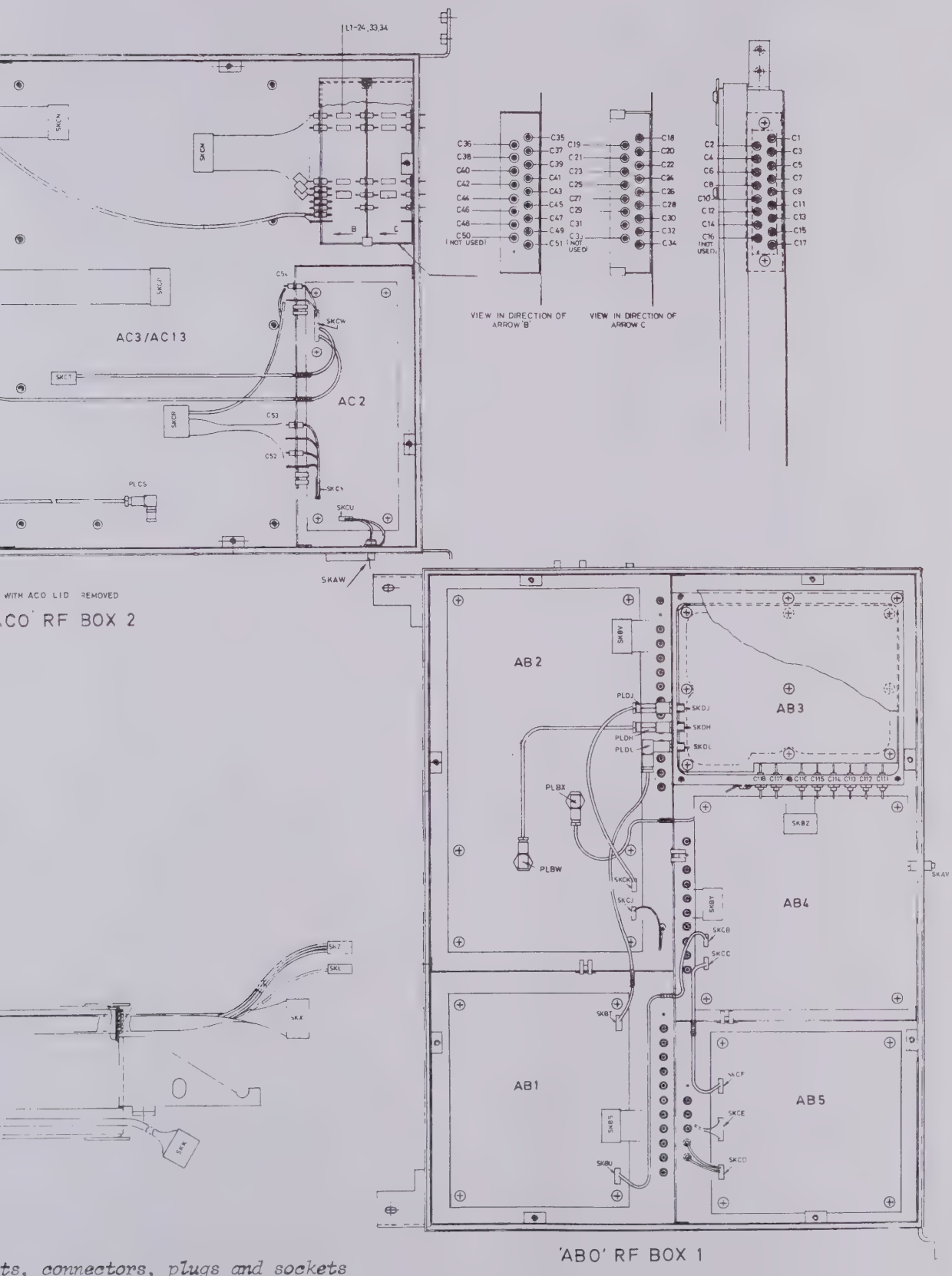



*Fig. 1b Location of compon*




WITH ACO LID REMOVED

'ACO' RF BOX 2

'ABO' RF BOX 1

*ts, connectors, plugs and sockets*

RF output

Test equipment : items a, RF electronic voltmeter
b, T connector
c, N type 50 Ω load
f, Power meter

13. The a.l.c. and fine attenuator output level is accurate to within ±0.5 dB for carrier frequencies up to 520 MHz and within ±1.0 dB for carrier frequencies from 520 to 1040 MHz. Test equipment shown in Fig. 2 below enables the output to be checked for carrier frequencies up to 50 MHz only. Output levels at frequencies higher than this should be checked using a power meter fitted with the appropriate tft head.

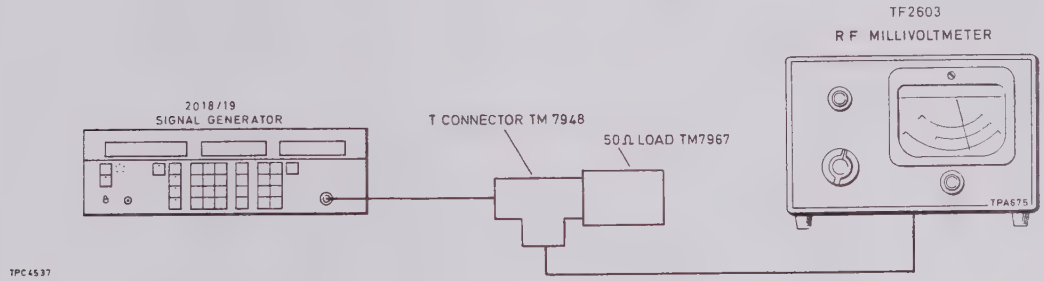



*Fig. 2 Test gear arrangement for r.f. output measurements*

14. Select an appropriate carrier frequency, AM OFF, RF LEVEL +13 dBm, increment the RF LEVEL in steps of 0.1 dB and check that the output level remains accurate down to a level of -3 dBm. Selection of levels below -2.9 dBm include the operation of the coarse attenuator and although the output may be measured at any level low power measurements require the use of specialized attenuator measuring equipment.

Coarse attenuator functional check

Test equipment : item k, Spectrum analyser

15. The 10 dB step attenuator contains three 30 dB pads, one 20 dB pad and one 10 dB pad. Each of these may be selected individually by utilizing the second function 3 mode. Connect the spectrum analyser to the RF OUTPUT socket and select +3 dBm on the 2018. The coarse attenuator AT0 is controlled from AD2 motherboard, address A6L10. To select each of the relays in turn carry out the following procedure:-

(1) Select SECOND FUNCT 3.

(2) Select by means of the instrument keyboard, the address valid followed by the address latch number. The modulation display window will indicate 06 and the RF level display window 10.

(3) Enter the data in binary 1 or 0 from the keyboard, numbers are rotated in from the right and are displayed in the carrier frequency window. Each relay may be selected by the binary number shown below in Table 4.

*TABLE 4 AT0 ATTENUATOR FUNCTIONAL CHECK*

| *Binary No.* | | | | | | | | *Relay de-energized* | *Attenuator pad* | *RF output* |
|---|---|---|---|---|---|---|---|---|---|---|
| *D7* | *D6* | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* | | | |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | RLE | 10 dB | -3 dBm |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | RLD | 20 dB | -13 dBm |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | RLC | 30 dB | -23 dBm |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | RLB | 30 dB | -23 dBm |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | RLA | 30 dB | -23 dBm |

(4) Check that the output level falls to the appropriate level on the Spectrum analyser as each attenuator pad is selected.

16. The only electrical adjustment provided on AT1 board is a series of flags which may be used to adjust the calibration of each pad. In the 0 dB attenuation condition the attenuator has an insertion loss which is dependent upon the frequency selected. This insertion loss is compensated for by the ALC system on AC4. The flags are used to adjust the attenuation of each pad so that the difference between the attenuation of each pad being in or out is equal to the nominal attenuation of the pad at 1 GHz. To carry out comprehensive attenuator accuracy checks and realignment requires each pad to be separately set up using specialized measuring facilities and it is recommended that this be carried out only by the nearest Marconi Instruments agent or Service Division.

Modulation oscillator performance

Test equipment : items d, Digital frequency meter
g, Distortion factor meter

17. To test the frequency, distortion and output of the modulation oscillator proceed as follows:-

(1) Connect the frequency meter to the MOD INPUT/OUTPUT socket of the instrument using a BNC type connector (nominal output level and source impedance is 1 V e.m.f. and 1 kΩ respectively).

(2) Select by successive presses of the MOD OSC key each of the five pre-set modulation frequencies checking that the frequency indicated corresponds to the one selected ±5% and that each l.e.d. indicator on the instrument is lit as appropriate.

(3) Disconnect the frequency meter and connect the distortion factor meter. The measured distortion should not exceed 0.3%.

(4) Switch the distortion factor meter to Hi Z and check the output level. This should be greater than 800 mV e.m.f.

FM deviation

Test equipment : item h, AM/FM modulation meter

18. To check the deviation accuracy proceed as follows:-

(1) Select CARRIER FREQ 100 MHz, MOD OSC 1 kHz, FM 100 kHz.

(2) Connect the TF 2300B to the RF OUTPUT socket and tune to the carrier frequency.

(3) Measure the deviation and check that it is within ±5% of the selected deviation.

(4) Repeat the test for other deviation frequencies within the range of the instrument (1% of the carrier frequency in use).

FM tracking

Test equipment : item h, AM/FM modulation meter

19. To check the f.m. tracking proceed as follows:-

(1) Connect the modulation meter to the RF OUTPUT socket.

(2) Set to FM 100 kHz, MOD OSC 1 kHz, RF LEVEL +1 dBm.

(3) Tune modulation meter to various carrier frequencies between 261 and 520 MHz and check that the output deviation remains at 100 kHz ±5%.

AM depth

Test equipment : item h, AM/FM modulation meter

20. To check the a.m. depth proceed as follows:-

(1) Select CARRIER FREQ 100 MHz, AM 80%, MOD OSC 1 kHz, RF LEVEL ~~+120 dBμV e.m.f~~ +7 dBm.

(2) Connect the modulation meter r.f. input to the 2018 RF OUTPUT socket.

(3) Tune the modulation meter to the 2018 carrier frequency and check that the a.m. depth is accurate to within ±4% of depth setting +1%.

(4) Check the a.m. depth at other carrier frequencies up to 400 MHz.

21. If a modulation meter is not available the a.m. depth can be assessed by using an oscilloscope to measure the peak and trough values of the modulation envelope. The a.m. depth is then determined by

$$\text{AM depth } \% = \frac{Vp - Vt}{Vp + Vt} \times 100$$

where Vp and Vt are the measured peak-to-peak and trough-to-trough amplitudes respectively.

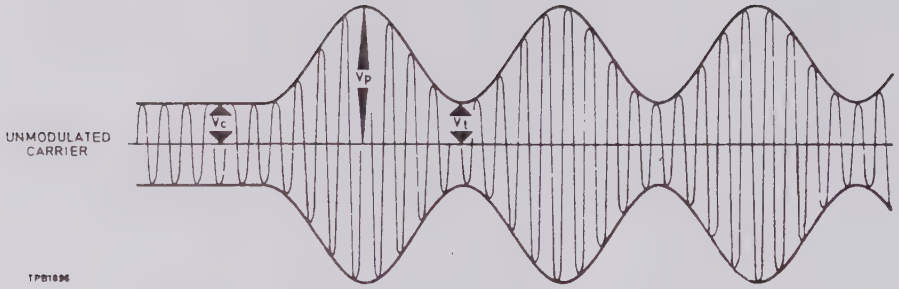



*Fig. 3 Modulation depth measurement*

External f.m. modulation sensitivity (ALC)

Test equipment : items h, AM/FM modulation meter
i, AF oscillator
l, AF voltmeter

22. The modulation level should remain reasonably constant for a given change in external modulation voltage and frequency. This sensitivity is checked as follows:-

(1) Connect the test equipment as shown in Fig. 4.

(2) Select FM 300 kHz, MOD OSC 1 kHz, CARRIER FREQ 30 MHz, RF LEVEL 0 dBm, check that the internal modulation oscillator frequency is 1 kHz ±40 Hz at a level of 1 V ±0.25 V.

(3) Set 2018 to FM EXT, ALC ON, set the AF oscillator to give a 1 kHz, 1 V amplitude output and check that the f.m. deviation is the same as that for internal modulation.

(4) Vary the input voltage between 0.8 and 1.2 V and check that the deviation remains constant.

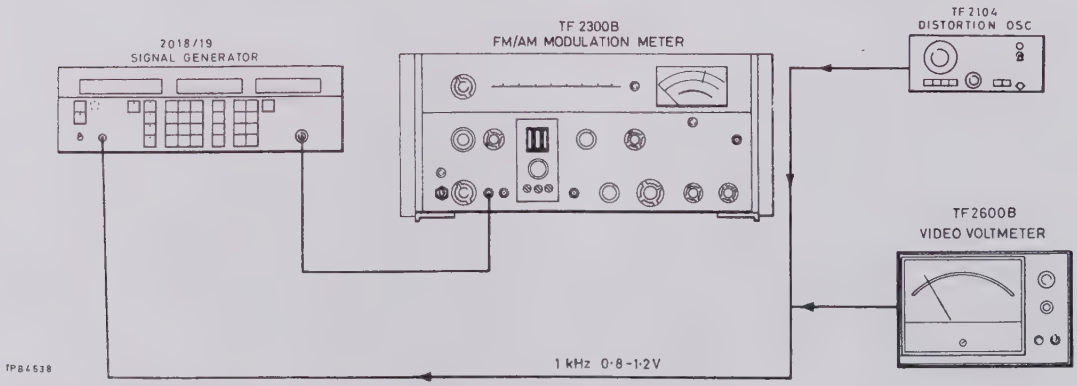



*Fig. 4 Test gear arrangement for the checking of external modulation sensitivity*

AM distortion

Test equipment : items g, Distortion factor meter
h, AM/FM modulation meter

23. To check the internal a.m. distortion proceed as follows:-

(1) Connect the test equipment as shown in Fig. 5 below.

(2) Select CARRIER FREQ 100 MHz, MOD OSC 1 kHz, AM 80%, RF LEVEL 7 dBm.

(3) Tune the modulation meter to the 100 mHz signal, checking that the distortion factor does not exceed an indicated 3% reading.

(4) Repeat the test with CARRIER FREQ set to 400 MHz.

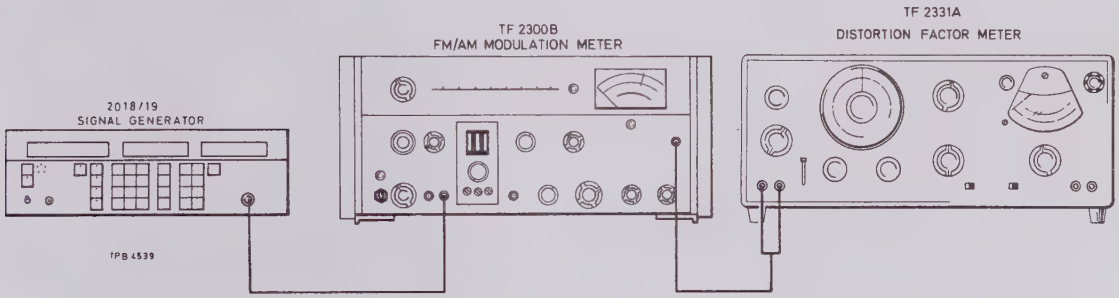



*Fig. 5 Test gear arrangement for checking f.m. and a.m. distortion*

FM distortion

Test equipment : items g, Distortion factor meter
h, AM/FM modulation meter

24. To check the f.m. distortion proceed as follows:-

(1) Connect the test equipment as shown in Fig. 5. Select CARRIER FREQ 30 MHz, MOD OSC 1 kHz, FM 200 kHz.

(2) Tune the modulation meter to the instrument and check that the distortion is not in excess of 3%.

(3) Repeat the test for other amounts of deviation. The distortion over the total range should not exceed 3% for deviations of up to 70% of the maximum available at any carrier frequency.

VSWR (5 MHz to 1 GHz)

Test equipment : items m, Oscilloscope with dual trace capability
p, Sweep oscillator & RF plug-in unit
q, Rho-bridge with standard loads and calibrated mismatches

25. The impedance measurement may be carried out over almost all the frequency range of the instrument. Connect the test equipment as shown in Fig. 6 below.

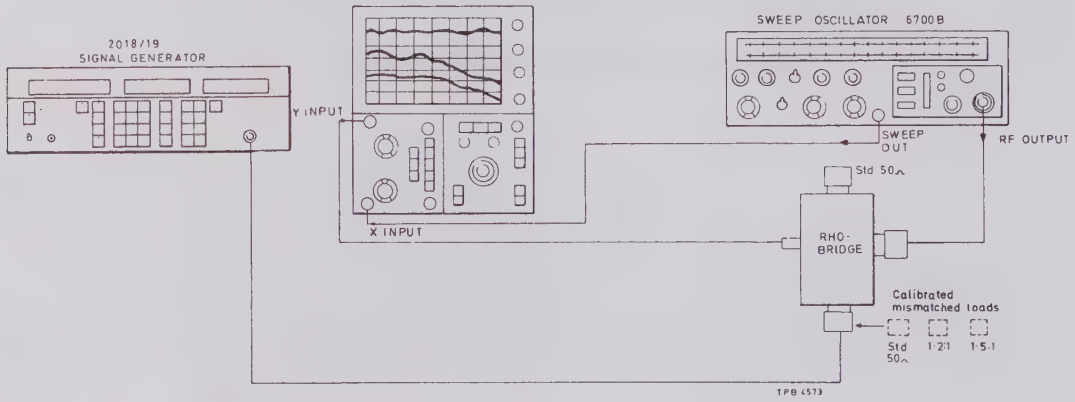



*Fig. 6 Test gear arrangement to check v.s.w.r.*

(1) Set the sweep oscillator to F1-F2 and sweep from 5 MHz to 520 MHz, insert standard 50 Ω loads into the rho-bridge and set datum point near the top of the oscilloscope display. Replace one 50 Ω with a 1.2:1 mismatched load and adjust the d.c. output of the rho-bridge so that the vertical deflection of the oscilloscope occupies 5 or 6 c.m.s. for the mismatch change. Using a chinagraph draw the pattern on the oscilloscope graticule.

(2) Remove the mismatched load and connect the 2018/2019 to the rho-bridge instead. Check that the v.s.w.r. does not exceed 1.2:1 with the RF LEVEL selected to -4 dBm or less.

(3) For 2019 Signal Generators repeat steps (1) and (2) sweeping this time from 5 MHz to 1 GHz and using the 1.5:1 mismatched load to check that the v.s.w.r. does not exceed 1.5:1.

Carrier harmonics and spurious signals

Test equipment : item k, Spectrum analyser

26. To check the level of harmonics of the carrier frequency in a c.w. output proceed as follows:-

(1) Connect the spectrum analyser to the RF OUTPUT socket and set the instrument to give a c.w. output at a convenient level below +7 dBm (1 V e.m.f.).

(2) Tune the instrument through its r.f. range and check that the amplitude of any harmonic is greater than 30 dB down on the fundamental for carrier frequencies from 80 kHz to 520 MHz, and 20 dB down on carrier frequencies 520 MHz to 1040 MHz (2019).

Reverse power protection

Test equipment : items e, Multimeter
o, Variable d.c. power supply

27. Set the d.c. power supply to +5 V and apply this to the 2018 RF OUTPUT 50 Ω socket causing the RPP circuit to trip.

(1) An indication that the REV PWR LIMIT has been exceeded is given in the RF LEVEL display window, a further indication of trip is given by the RF LEVEL function keys integral l.e.d. This will continually flash until the reset is operated.

(2) Remove the +5 V source and check that there is no continuity between the 'N' type connector centre pin and earth (taking care not to damage the connector pin).

(3) Reset the RPP by pressing the RF LEVEL key and ensure that both trip indications are turned off. Set the d.c. power supply to -5 V and apply this again to the RF OUTPUT 50 Ω socket checking that the RPP once more trips. Remove the d.c. source and reset the RPP.

## FAULT LOCATION

Introduction

28. The following section consists of fault finding procedures, charts and tests to aid identifying faults. To assist with fault finding it is advisable to study the description of the overall instrument contained in Chap. 4. The functions of the various boards are generally well defined and independent of each other as far as possible and the parameters of the signals exchanged between them are not critical. All boards/modules are interconnected by a variety of connectors. A useful method of confirming if board or module is faulty is to substitute the unit with a unit that is known to be good (e.g. from a spare working instrument). This can save considerable fault finding time.

29. When disconnecting an r.f. connection between two units ensure that the metal clad connector cannot accidentally cause short circuits on the printed boards and create additional faults. If any of the ribbon cable connectors are unplugged ensure that when they are reconnected they are correctly posi-

tioned since the connectors do not incorporate polarizing plugs.

30. If any rectification work is carried out in areas containing chip components certain precautions should be taken. Always use solder containing 2% silver and use a high wattage temperature controlled soldering iron set to 315°C (600°F). The temperature controller should preferably directly sense and control the temperature of the soldering iron bit. The soldering iron tip should also be earthed in order to avoid potential damage to static sensitive devices. The chip resistors used in areas other than the 10 dB step attenuator have nickel barrier terminations and are virtually immune to termination leaking problems. The ceramic chip capacitors used have palladium silver terminations that can dissolve or weaken in molten solder. If there is any possibility that a termination has been weakened during rectification work the suspect device should be replaced.

31. A useful technique for checking the soundness of chip capacitor terminations is to set the carrier frequency as low as applicable to the relevant circuit and then GENTLY tap the printed board (not the chip component) with a blunt non-metallic object (e.g. the handle of a screwdriver) checking the circuit for any intermittent level changes. Chip components can be mechanically damaged by rough handling or excessive flexing of the printed boards.

Use of second function 3

32. Second function 3 can be used as a diagnostic aid under certain circumstances. Its use requires that the microprocessor system and the keyboard is working normally. Second function 3 may then be used to send data to any specified latch. This will enable the operator to establish that the correct data is arriving at the input to the latch by using a storage oscilloscope triggered from the clock input of the latch and observing the data at the latch input as the latch is clocked. Each latch is identified on the circuit diagram by a data valid line and an address e.g. on AC5 the address of the D-A converter, IC4, is given as A7L0. The data valid line is 7 and the latch address is 00 (2 digits are required L0 implies 00, L1 implies 01 etc.). Data can be sent to this latch by pressing the keys "SECOND FUNCT", "3", followed by the data valid line "7" and the latch address "0", "0", (2 digits). The data valid line will be displayed in the modulation display and the address is displayed in the r.f. level display. This is followed by entering a string eight binary digits (1's and 0's) corresponding to the data to be sent. Pressing the store key will cause the microprocessor to send the data to the specified latch. If the data that is being send needs to be sent again pressing the STORE key again will send the same data. If the data is to be modified this can be accomplished by entering a new string of data and then pressing the STORE key again.

33. Where data is to be sent to the 10 bit D-A type AD7522 the data has to be sent in two bytes. The least significant eight digits are sent first to one latch address (as specified in the control data information, this is stored in a buffer (inside the D-A chip). A new latch address is then entered corresponding to the most significant bits, followed by the required binary data. On pressing the STORE key this data is sent to the D-A and the D-A in turn is set to data specified by the whole 10 bit number. Any data sent via second function 3 remains in the receiving latch until one of the orange function keys is pressed. The microprocessor will then overwrite any data sent and restore the instrument to normal operation.

Maintenance kit

34. The maintenance kit contains the following items which may be used for fault finding and servicing.

(1) RF lead part number 43129-835R. A 20 cm long SMC female to SMC male connector assembly. Intended to be used when the upper r.f. box is raised for servicing. This lead enables the operator to reconnect the free end of the semi-rigid cable assembly PLAV to PLAX (which connects the synthesizer output from the upper r.f. box to the lower r.f. box) to SKAV in the upper r.f. box.

(2) RF lead part number 43129-834C. A 70 cm SMC to BNC lead to enable the output from SMC connectors to be monitored.

(3) RF lead part number 43129-836B. A 70 cm SMB to BNC lead to enable the output from SMB connectors to be monitored.

(4) Connector assembly part number 54129-833M. A 70 cm crimp to BNC lead to enable the output from a p.c.b. to be monitored where the output is on .025 in square wrap posts.

(5) Adapter part number 44828-753H. A 50 to 200 Ω adapter which can be used in conjunction with 43129-833 to monitor a 200 Ω output from a board on .025 in square wrap posts. The adapter introduces a 12 dB insertion loss.

(6) 3.7 in l.c.d. extraction tool part number 46883-531V.

(7) 4.7 in l.c.d. extraction tool part number 46883-530G.

(8) LCD insertion tool part number 46883-529S.

## FAULT FINDING TO BOARD LEVEL

35. The following section describes fault finding routines and algorithms which may be used to help diagnose faults down to board level. The fault finding routines start from a generalized fault condition and guide the operator to the most likely area of the fault. The generalized fault conditions used as a starting point are as follows:

(a) Front panel failure.

(b) Output frequency error.

(c) Output r.f. level error.

(d) Carrier harmonic problem.

(e) AM fault.

(f) FM fault.

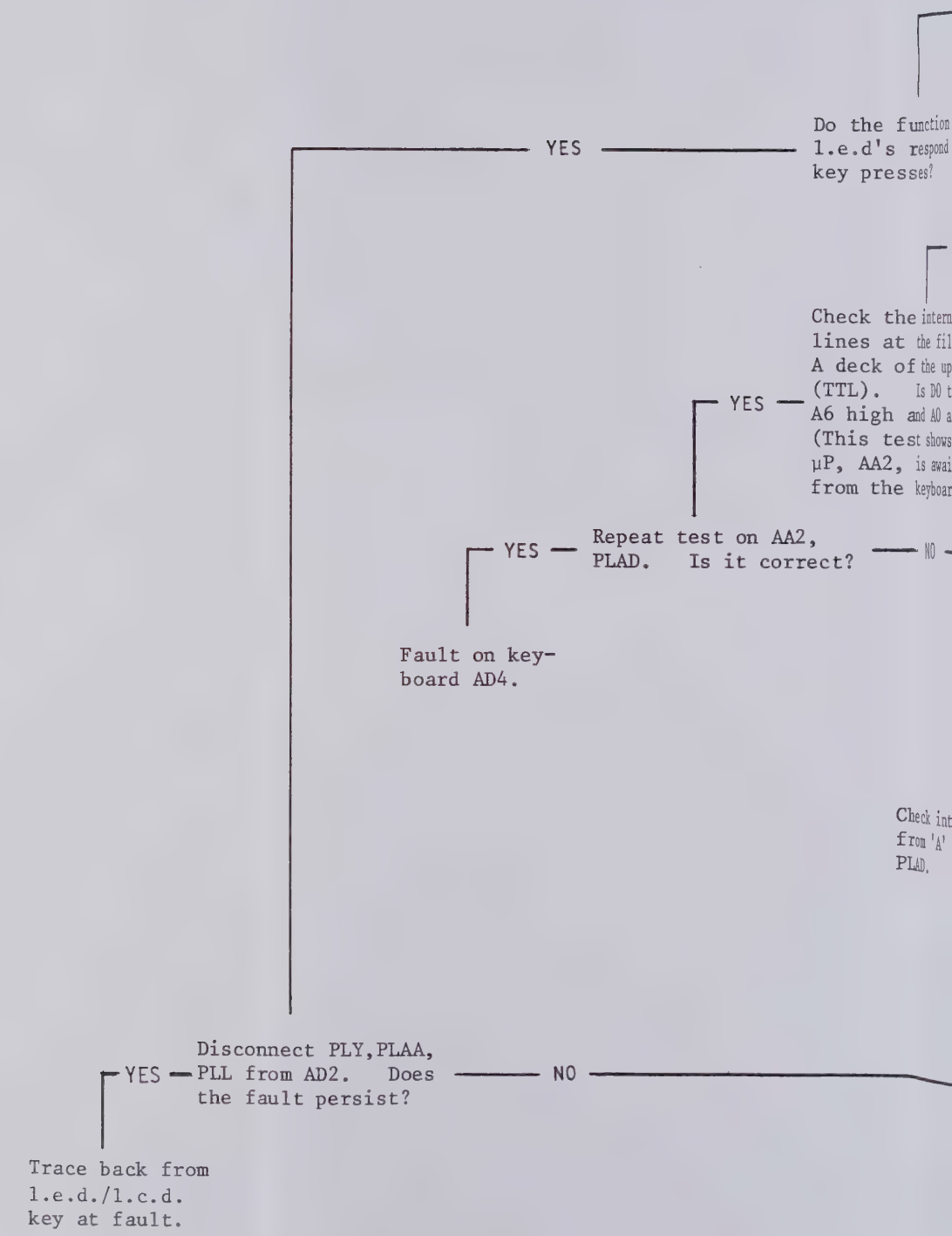
(g) Residual f.m. problems.

(h) RPP failure.

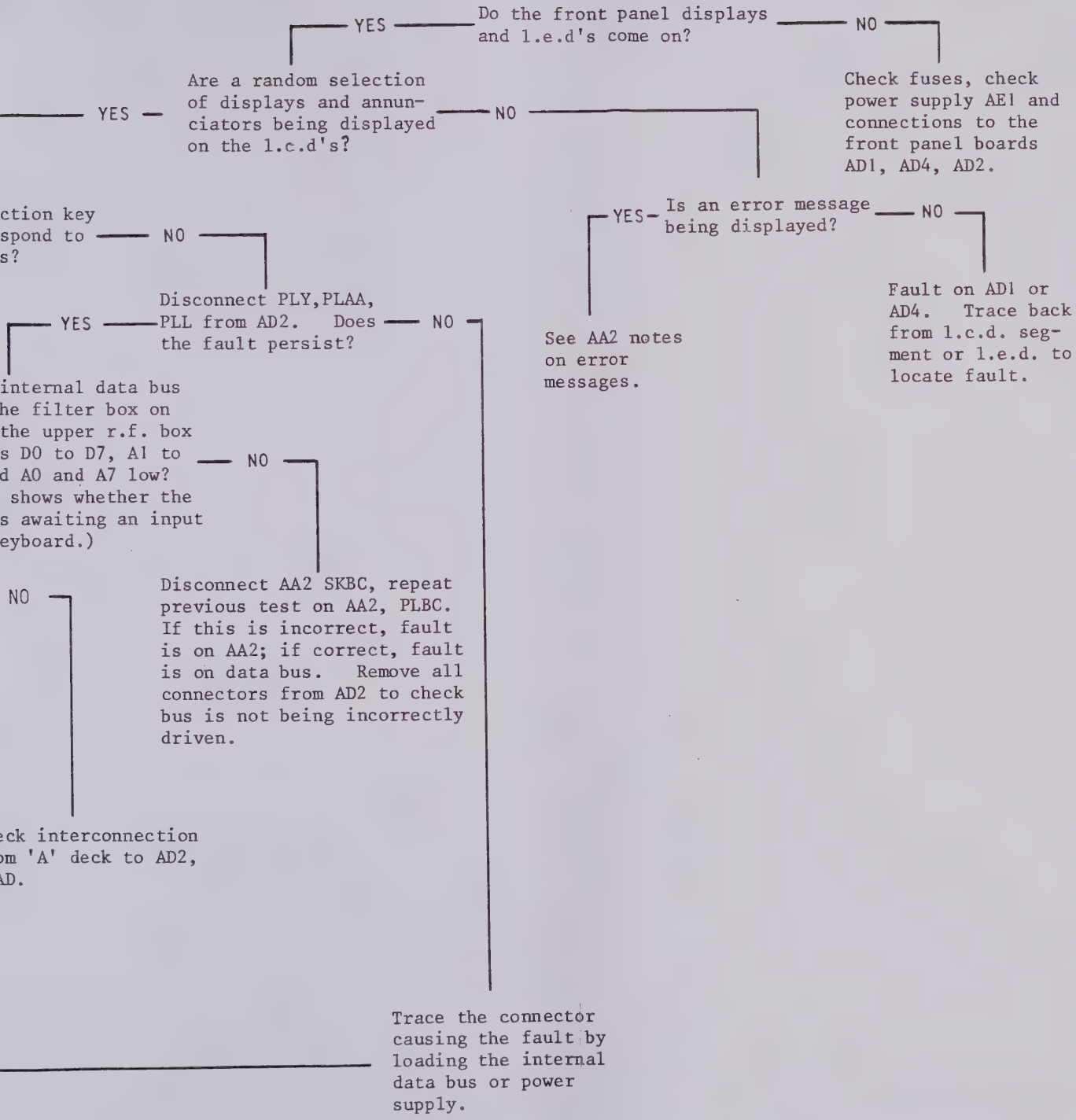
Choose the description that most closely describes the fault condition and use the fault finding guide to establish the area of the fault. Before using the fault finding tables read the notes that accompany the tables.

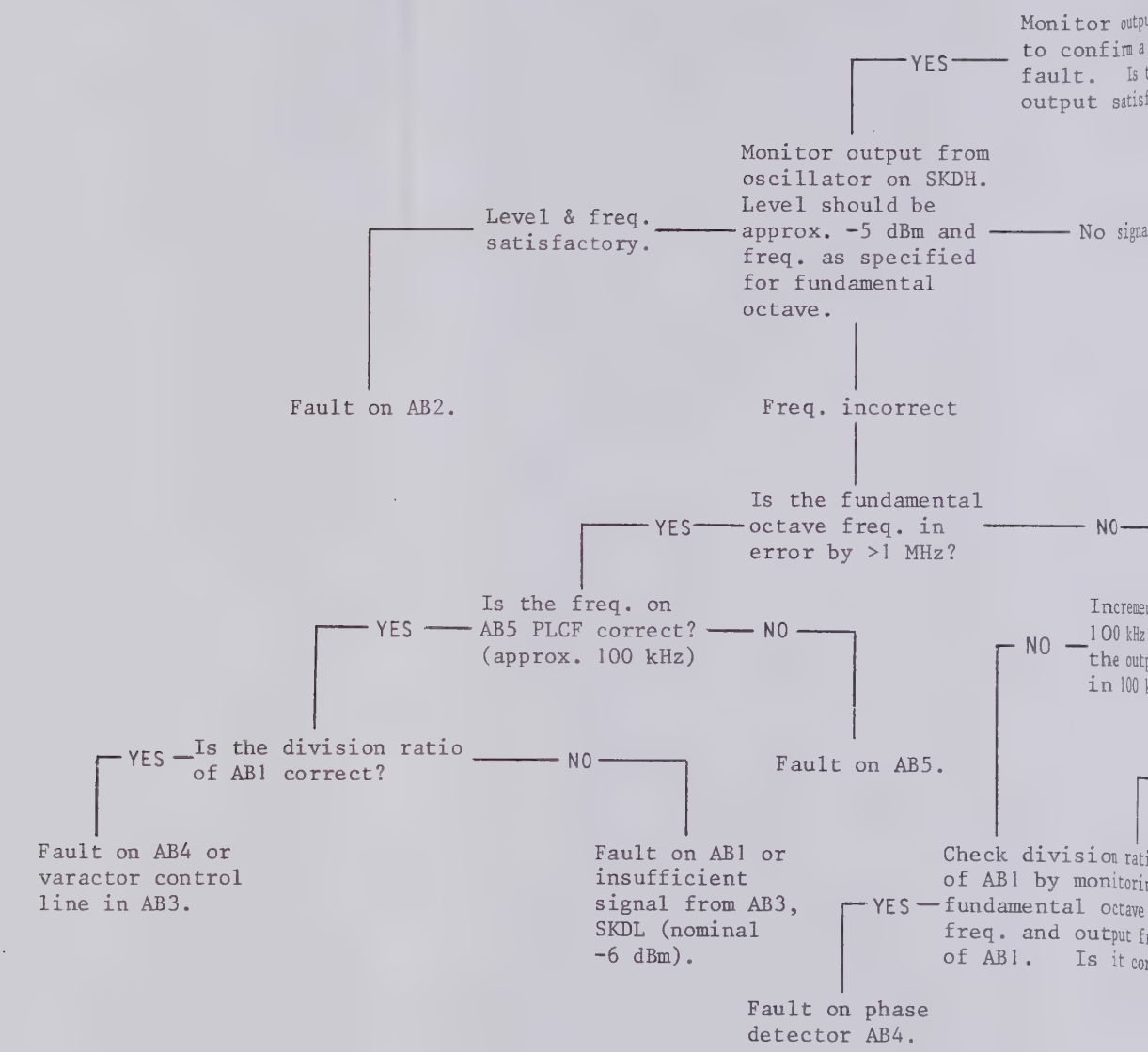
### Front panel failure

36. A chart to aid fault finding a front panel failure is given in Table 5. A front panel failure is defined as a fault in which the keyboard or the display is not operating correctly. One of the first objectives is to establish if the display or keyboard is causing the fault or whether the microprocessor system is not operating. If the microprocessor system is functioning but has a memory fault an error message will be displayed. The error message will appear as the letter P in the modulation display if there is a PROM error, a letter H if it is a RAM error, or a letter L if an EAROM check sum is invalid. In the event of a microprocessor failure in which the microprocessor cannot run the check sum no error message will be displayed. In this case testing to see if the microprocessor board is waiting for a keyboard press should indicate if the microprocessor program is running.

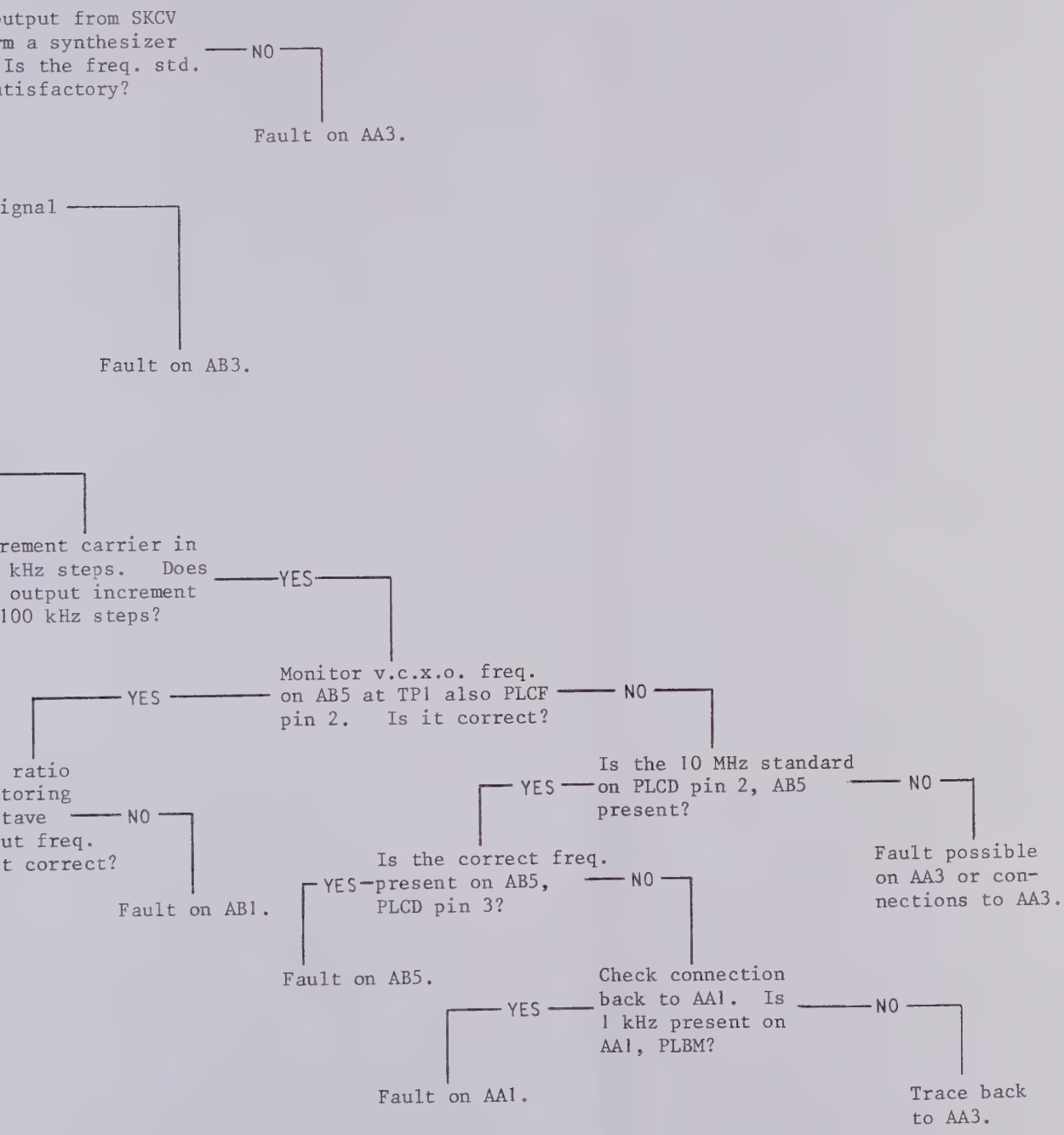

YES
Do the function
1.e.d's respond
key presses?
Check the intern
lines at the fil
A deck of the up
(TTL). Is DO t
A6 high and AO a
(This test shows
μP, AA2, is awai
from the keyboar
YES
Repeat test on AA2,
PLAD. Is it correct?
NO
YES
Fault on key-
board AD4.
Check int
from 'A'
PLAD.
Disconnect PLY,PLAA,
PLL from AD2. Does
the fault persist?
YES
NO
Trace back from
1.e.d./1.c.d.
key at fault.

*ANEL FAILURE*


Do the front panel displays and l.e.d's come on?
YES
NO
Check fuses, check power supply AE1 and connections to the front panel boards AD1, AD4, AD2.
Are a random selection of displays and annunciators being displayed on the l.c.d's?
YES
NO
Is an error message being displayed?
YES
NO
See AA2 notes on error messages.
Fault on AD1 or AD4. Trace back from l.c.d. segment or l.e.d. to locate fault.
ction key spond to s?
NO
Disconnect PLY,PLAA, PLL from AD2. Does the fault persist?
YES
NO
internal data bus he filter box on the upper r.f. box s D0 to D7, A1 to d A0 and A7 low? shows whether the s awaiting an input eyboard.)
NO
Disconnect AA2 SKBC, repeat previous test on AA2, PLBC. If this is incorrect, fault is on AA2; if correct, fault is on data bus. Remove all connectors from AD2 to check bus is not being incorrectly driven.
NO
eck interconnection om 'A' deck to AD2, AD.
Trace the connector causing the fault by loading the internal data bus or power supply.


YES
Monitor outp
to confirm a
fault. Is
output satisf
Monitor output from
oscillator on SKDH.
Level should be
approx. -5 dBm and
freq. as specified
for fundamental
octave.
No signa
Level & freq.
satisfactory.
Fault on AB2.
Freq. incorrect
Is the fundamental
octave freq. in
error by >1 MHz?
YES
NO
Is the freq. on
AB5 PLCF correct?
(approx. 100 kHz)
YES
NO
Increme
100 kHz
the outp
in 100
NO
Is the division ratio
of AB1 correct?
YES
NO
Fault on AB5.
Fault on AB4 or
varactor control
line in AB3.
Fault on AB1 or
insufficient
signal from AB3,
SKDL (nominal
-6 dBm).
Check divisio rat
of AB1 by monitori
fundamental octave
freq. and output f
of AB1. Is it co
YES
Fault on phase
detector AB4.

*REQUENCY ERROR*



Output frequency error

37. A chart to aid fault finding an output frequency error is given in Table 6. An output frequency error is defined as a fault in which the output carrier frequency, when measured using a frequency counter operating from the same frequency standard as the instrument, indicates that the output frequency differs from the value set.

38. If the instrument has been set to operate from an external frequency standard, ensure that an external standard of 10 MHz at 1 V r.m.s. across 50 Ω is applied to the external standard input on the rear panel. Since the output frequency is synthesized in the upper r.f. box any frequency synthesis fault is likely to be in the upper r.f. box with the exception of frequencies below 2.03125 MHz. Faults confined to this b.f.o. band are covered in the section relating to r.f. level faults. For ease of fault finding the r.f. output from the SMC connector, SKAV, at the rear of the upper r.f. box should be used to monitor the output frequency. The output level from this connector should be approximately 0 dBm but its absolute level and flatness is not critical. The waveform is nominally a square wave and so it has a high harmonic content. Certain frequency counters and modulation analysers may be prone to acquiring harmonic frequencies of the output.

39. The carrier frequency is synthesized over the frequency range 260 to 520 MHz (the fundamental octave) and then divided down by factors of two. If the fault exists on the fundamental octave it is always easier to locate the fault with the instrument set on this range, since it is easier to calculate the intermediate frequencies used to generate the output. Before starting to fault find, read and understand the description of the synthesizer given in Chap. 4 since it may be necessary to calculate the intermediate frequencies very precisely in order to locate the fault. When dealing with small frequency errors it is advisable to operate the counter measuring the output frequency from the same frequency standard as the instrument.

RF level fault

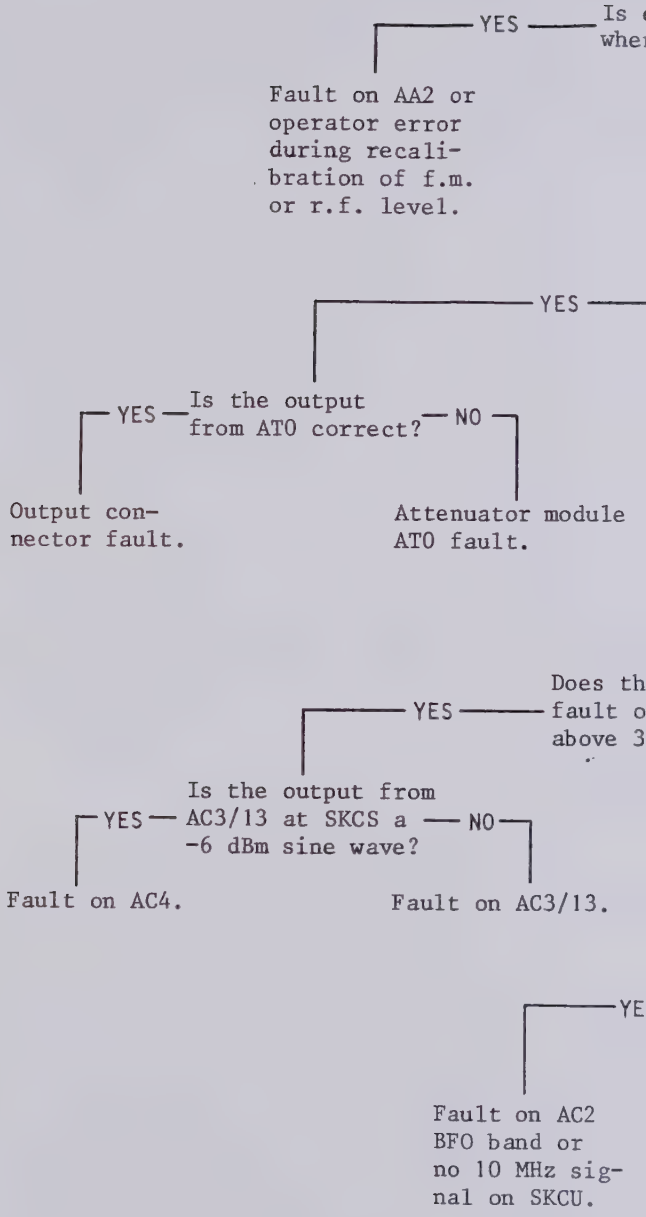
40. A chart to aid fault finding an r.f. level fault is given in Table 7. An r.f. level fault is defined as a failure which results in the r.f. level being out of specification but the carrier frequency is correct and the output signal is not unduly distorted. In assessing if the r.f. level is out of specification the r.f. offset facility should be switched off (second function 7). It is also assumed that the error is such that the instrument does not just require recalibrating.

41. The r.f. level accuracy is set up using second function 7. If it is found that the instrument is out of calibration but can be recalibrated using second function 7 it is possible that the fault is due to the EAROM store on AA2 not permanently storing data (see fault finding AA2). Usually (but not always) such faults will also be accompanied by f.m. tracking faults and failure to store instrument settings, r.f. level units or GPIB address. RF level errors are only likely to originate in the lower r.f. box, the attenuator module, or the associated control systems and connectors. The lower r.f. box derives its input from the upper r.f. box via SKAW as a nominal 0 dBm square wave. Because the Amplitude Modulator AC5 acts as a signal limiter the input level to AC5 is not critical.

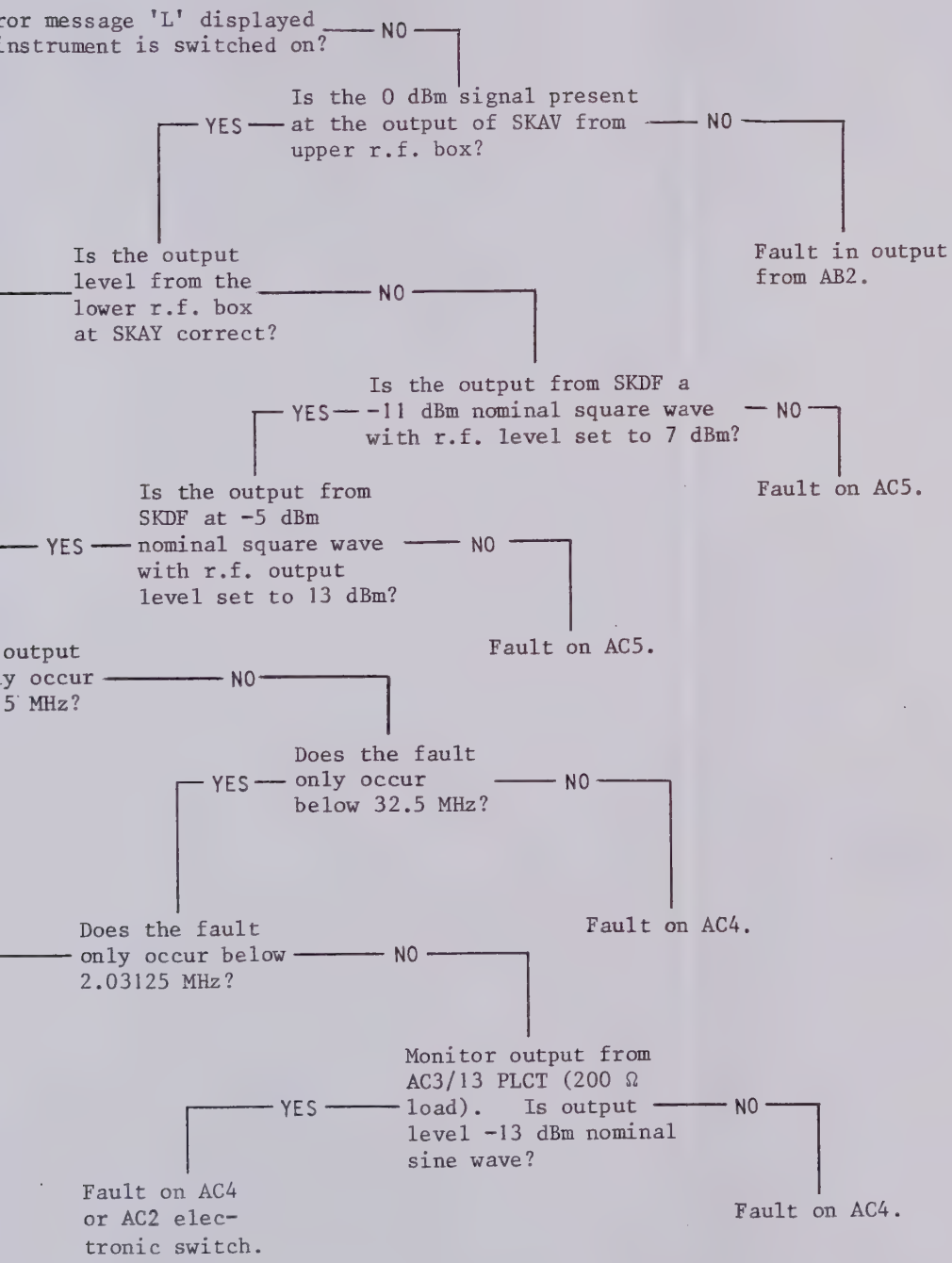
42. For carrier frequencies above 32.5 MHz the square wave output from AC5 is routed through a low-pass filter bank on AC3/13. The filters convert the signal into a sine wave at SKCS of AC3/13. Frequencies above 520 MHz are generated by a frequency doubler on AC13 (2019 only) and also appear on SKCS of AC13. The signal then goes to AC4 via PLCS and is amplified by a variable gain amplifier before going onto the output stages of AC4. RF level faults which are confined to frequencies above 32.5 MHz are most likely to arise because of faults in the filters of AC3/13 or the r.f. amplifiers on AC4.

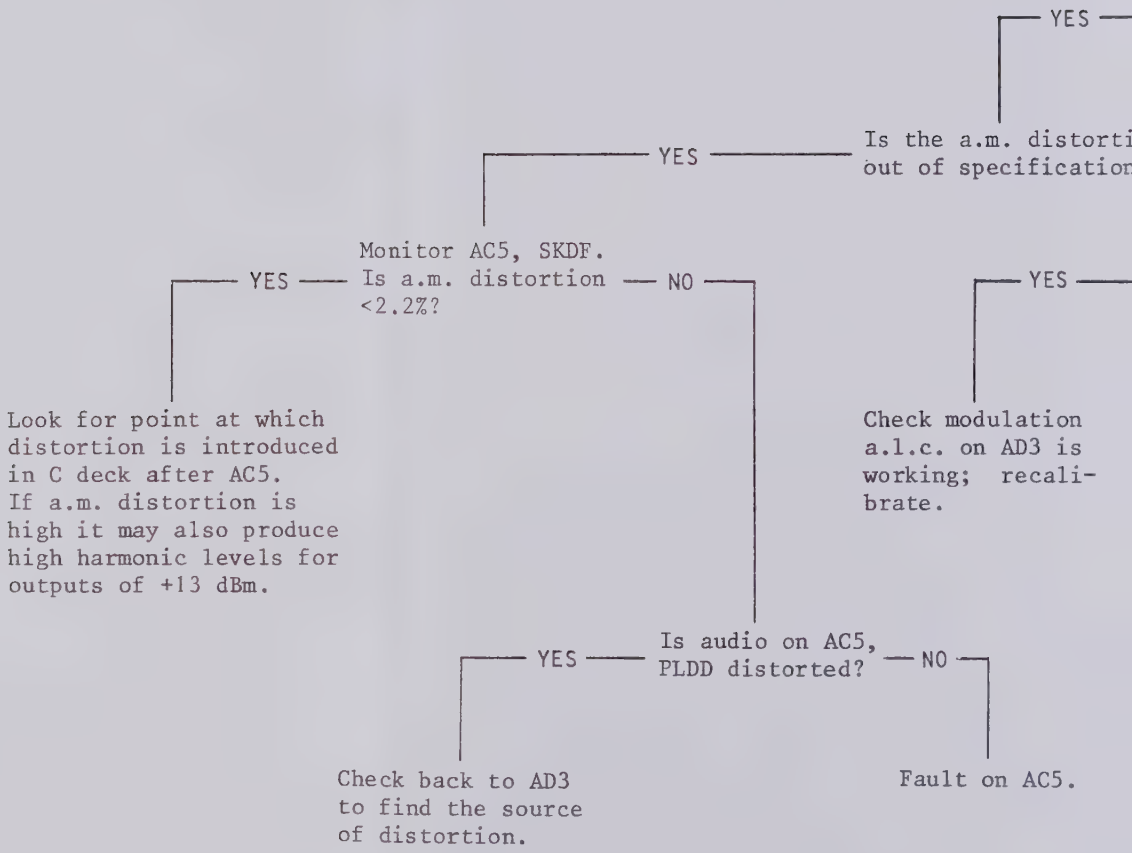
43. Frequencies below 32.5 MHz are routed through a bank of low-pass filters on AC3/13. If the output frequency is above 2.03125 MHz it is then routed to AC2 via PLCT and then to a variable gain amplifier on AC4. If the required output frequency is below 2.03125 MHz a 10 MHz to 12.03125 MHz signal is routed to AC2 via PLCW in order to be mixed with 10 MHz to produce the low frequency signal. RF level faults which are confined to frequencies below 32.5 MHz can therefore originate anywhere along this signal path. It should be noted that much of this low frequency signal path is operating in a 200 Ω system and not the more usual 50 Ω system. For this reason when using a 500 Ω probe to fault find along the signal path some allowance must be made for the loading effects of the probe. If it is required to monitor the output from PLCT of AC3/13 with a 50 Ω spectrum analyser or modulation meter with SKCT disconnected then a series 150 Ω resistor should be used (at the SKCT end) to convert the load into 200 Ω and due allowance made for the resulting insertion loss of 12 dB.

44. RF level faults can be caused if the amplifier system has too much or too little gain and the a.l.c. is therefore unable to control the signal level correctly. The 2018 has been designed to have a considerable gain margin and a typical instrument will have a margin of 8 dB at its worst frequency. The gain margin can be checked if necessary by first setting the output level to 7 dBm and then shorting the junction of R44 and R45 of AC5 to ground using a screwdriver or similar implement. The output level should rise by at least 3 dB (typically a minimum of 8 dB). The signal chain can then be tested for having too much gain by setting the output level to -2.9 dBm and then shorting the junction of R87 and R90 on AC4 to ground. The output level should fall by at least 4 dB.

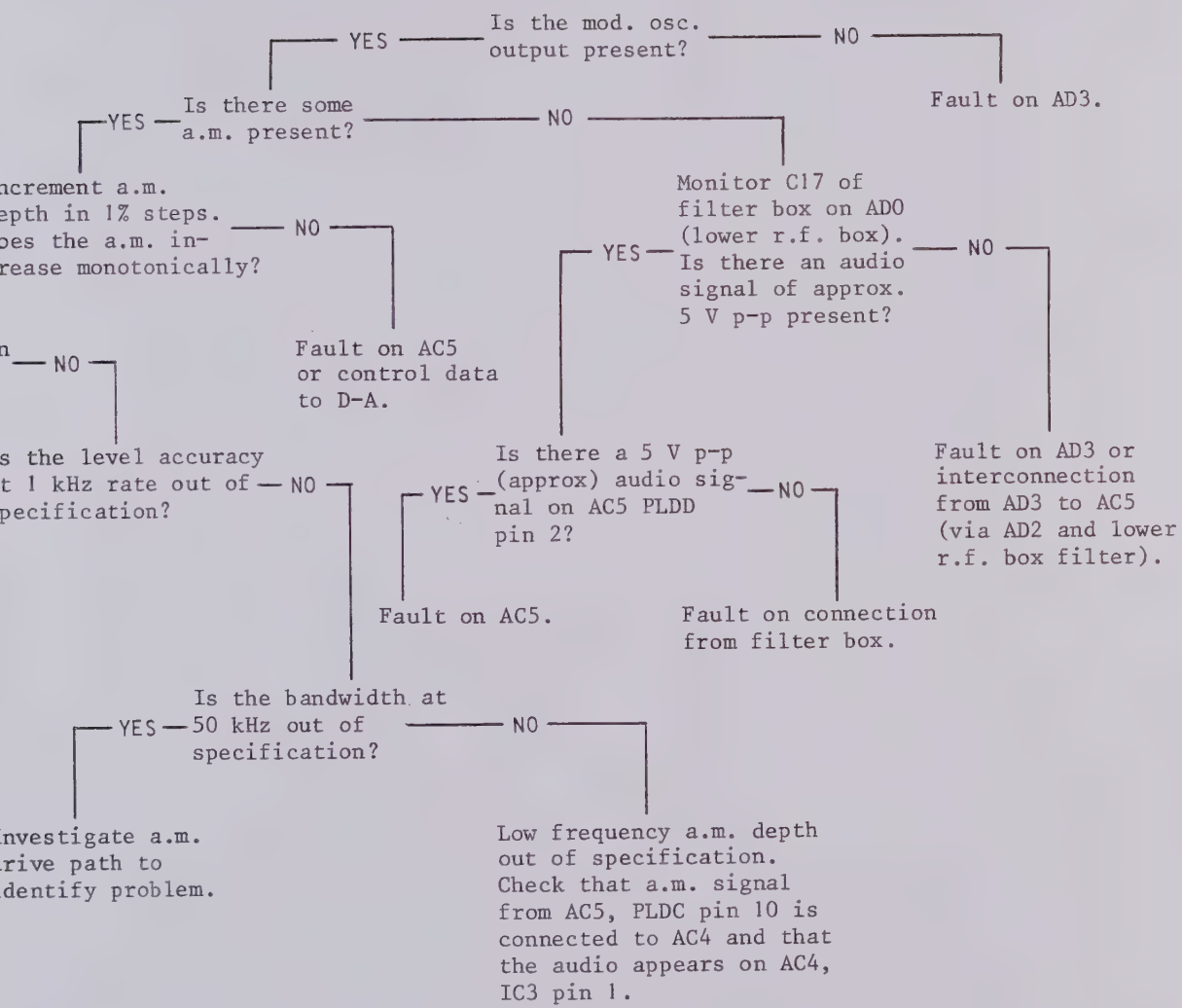

YES
Is
whe
Fault on AA2 or operator error during recali-bration of f.m. or r.f. level.
YES
YES
Is the output from AT0 correct?
NO
Output con-nector fault.
Attenuator module AT0 fault.
Does th
fault o
above 3
YES
Is the output from AC3/13 at SKCS a -6 dBm sine wave?
YES
NO
Fault on AC4.
Fault on AC3/13.
YE
Fault on AC2 BFO band or no 10 MHz sig-nal on SKCU.

*BLE 7 RF LEVEL FAULT*


ror message 'L' displayed
instrument is switched on?
NO
Is the 0 dBm signal present at the output of SKAV from upper r.f. box?
YES
NO
Fault in output from AB2.
Is the output level from the lower r.f. box at SKAY correct?
NO
Is the output from SKDF a -11 dBm nominal square wave with r.f. level set to 7 dBm?
YES
NO
Fault on AC5.
Is the output from SKDF at -5 dBm nominal square wave with r.f. output level set to 13 dBm?
YES
NO
Fault on AC5.
output
y occur
5 MHz?
NO
Does the fault only occur below 32.5 MHz?
YES
NO
Fault on AC4.
Does the fault only occur below 2.03125 MHz?
NO
Monitor output from AC3/13 PLCT (200 Ω load). Is output level -13 dBm nominal sine wave?
YES
NO
Fault on AC4 or AC2 electronic switch.
Fault on AC4.


YES
Is the a.m. distorti
out of specificatio
YES
Monitor AC5, SKDF.
Is a.m. distortion
<2.2%?
YES
NO
YES
Look for point at which
distortion is introduced
in C deck after AC5.
If a.m. distortion is
high it may also produce
high harmonic levels for
outputs of +13 dBm.
Check modulation
a.l.c. on AD3 is
working; recali-
brate.
Is audio on AC5,
PLDD distorted?
YES
NO
Check back to AD3
to find the source
of distortion.
Fault on AC5.

*AM FAULT*


Is the mod. osc. output present?
YES
NO
Fault on AD3.
Is there some a.m. present?
YES
NO
ncrement a.m. epth in 1% steps. oes the a.m. in- rease monotonically?
NO
Fault on AC5 or control data to D-A.
n
NO
s the level accuracy t 1 kHz rate out of pecification?
NO
Monitor C17 of filter box on AD0 (lower r.f. box). Is there an audio signal of approx. 5 V p-p present?
YES
NO
Fault on AD3 or interconnection from AD3 to AC5 (via AD2 and lower r.f. box filter).
Is there a 5 V p-p (approx) audio signal on AC5 PLDD pin 2?
YES
NO
Fault on AC5.
Fault on connection from filter box.
Is the bandwidth at 50 kHz out of specification?
YES
NO
nvestigate a.m. rive path to dentify problem.
Low frequency a.m. depth out of specification. Check that a.m. signal from AC5, PLDC pin 10 is connected to AC4 and that the audio appears on AC4, IC3 pin 1.

Harmonic distortion fault

45. Investigating harmonic distortion faults is usually a straightforward problem so a fault finding algorithm has not been provided. Until the signal arrives on AC3/13 its harmonic content has little effect on the performance of the instrument. On AC3/13 the nominal square wave is filtered by a bank of low-pass filters which converts the signal into a sine wave.

46. For problems above 32.5 MHz monitor the nominal -6 dBm signal from SKCS of AC3/13. If the harmonic content is high the fault is on AC3/13. If the harmonics are -40 dBc or better the fault is on AC4. For problems below 32.5 MHz trace the signal path from the filters on AC3/13 to AC2 and AC4 and identify where the harmonic problems start. Much of the low frequency channel operates in a 200 Ω transmission system so care must be taken not to load the system with less than 500 Ω when probing the signal path.

AM fault

47. An a.m. fault finding algorithm is given in Table 8. It is assumed that the output frequency is correct and the r.f. level accuracy and harmonic distortion is in specification. The fault finding algorithm first establishes if the fault is inside the lower r.f. box or is on AD2 or AD3.

48. When monitoring the output from SKDF AC5 it should be remembered that the output signal is a square wave and the modulation meter used must be capable of rejecting the high level of carrier harmonics present. If the modulation meter is automatically tuned care should be taken to ensure that the instrument tunes to the fundamental and not a harmonic.

FM fault

49. An f.m. fault finding algorithm is given in Table 10. The f.m. drive system is complicated by the requirement to provide f.m. tracking and range scaling to account for the division or multiplication by two of the fundamental octabe as well as providing fine control of the deviation. Most of the algorithm is therefore devoted to identifying which part of the control system is at fault.

50. Information on the use of second function 8 is given in the calibration section. In addition second function 3 can be used to check that the various digital to analogue converters are working. A digital a.c. voltmeter can be used to check the input and output levels of a D-A converter and hence establish if the gain of the converter is correct. If the divide-by-two system dividing the f.m. deviation is at fault it should be remembered that the division is accomplished using a divide-by-four system on AB2 as well as a divide-by-two, IC17, on AD3.

51. As an aid to diagnosing a fault in the f.m. tracking store Table 9 gives a list of the carrier frequencies used as f.m. tracking points together with the typical values of f.m. tracking data. Typically instruments will be within approximately 20% of the listed values.

*TABLE 9 TYPICAL FM TRACKING DATA*

| *OSC 1* | | *OSC 2* | | *OSC 3* | | *OSC 4* | |
|---|---|---|---|---|---|---|---|
| *Frequency* | *Data* | *Frequency* | *Data* | *Frequency* | *Data* | *Frequency* | *Data* |
| 260.00001 | 164 | 309.00001 | 157 | 368.00001 | 136 | 437.00001 | 113 |
| 262.45 | 182 | 311.95 | 166 | 371.45 | 142 | 441.15 | 118 |
| 264.9 | 186 | 314.9 | 180 | 374.9 | 150 | 445.3 | 125 |
| 267.35 | 183 | 317.85 | 178 | 378.35 | 150 | 449.45 | 125 |
| 269.8 | 187 | 320.8 | 182 | 381.8 | 151 | 453.6 | 127 |
| 272.25 | 189 | 323.75 | 183 | 385.25 | 150 | 457.75 | 127 |
| 274.7 | 189 | 326.7 | 183 | 388.7 | 150 | 461.9 | 127 |
| 277.15 | 189 | 329.65 | 182 | 392.15 | 145 | 466.05 | 123 |
| 279.6 | 189 | 332.6 | 174 | 395.6 | 142 | 470.2 | 123 |
| 282.05 | 187 | 335.55 | 169 | 399.05 | 142 | 474.35 | 117 |
| 284.5 | 182 | 338.5 | 171 | 402.5 | 134 | 478.5 | 117 |
| 286.95 | 183 | 341.45 | 167 | 405.95 | 131 | 482.65 | 112 |
| 289.4 | 180 | 344.4 | 157 | 409.4 | 131 | 486.8 | 113 |
| 291.85 | 178 | 347.35 | 159 | 412.85 | 125 | 490.95 | 110 |
| 294.3 | 175 | 350.3 | 155 | 416.3 | 125 | 495.1 | 107 |
| 296.75 | 175 | 353.25 | 150 | 419.75 | 123 | 499.25 | 107 |
| 299.2 | 175 | 356.2 | 151 | 423.2 | 121 | 503.4 | 106 |
| 301.65 | 175 | 359.15 | 150 | 426.65 | 121 | 507.55 | 106 |
| 304.1 | 176 | 362.1 | 152 | 430.1 | 121 | 511.7 | 106 |
| 306.55 | 175 | 365.05 | 155 | 433.35 | 121 | 515.85 | 109 |
| 309 | 177 | 368 | 154 | 437 | 121 | 520.0 | 108 |

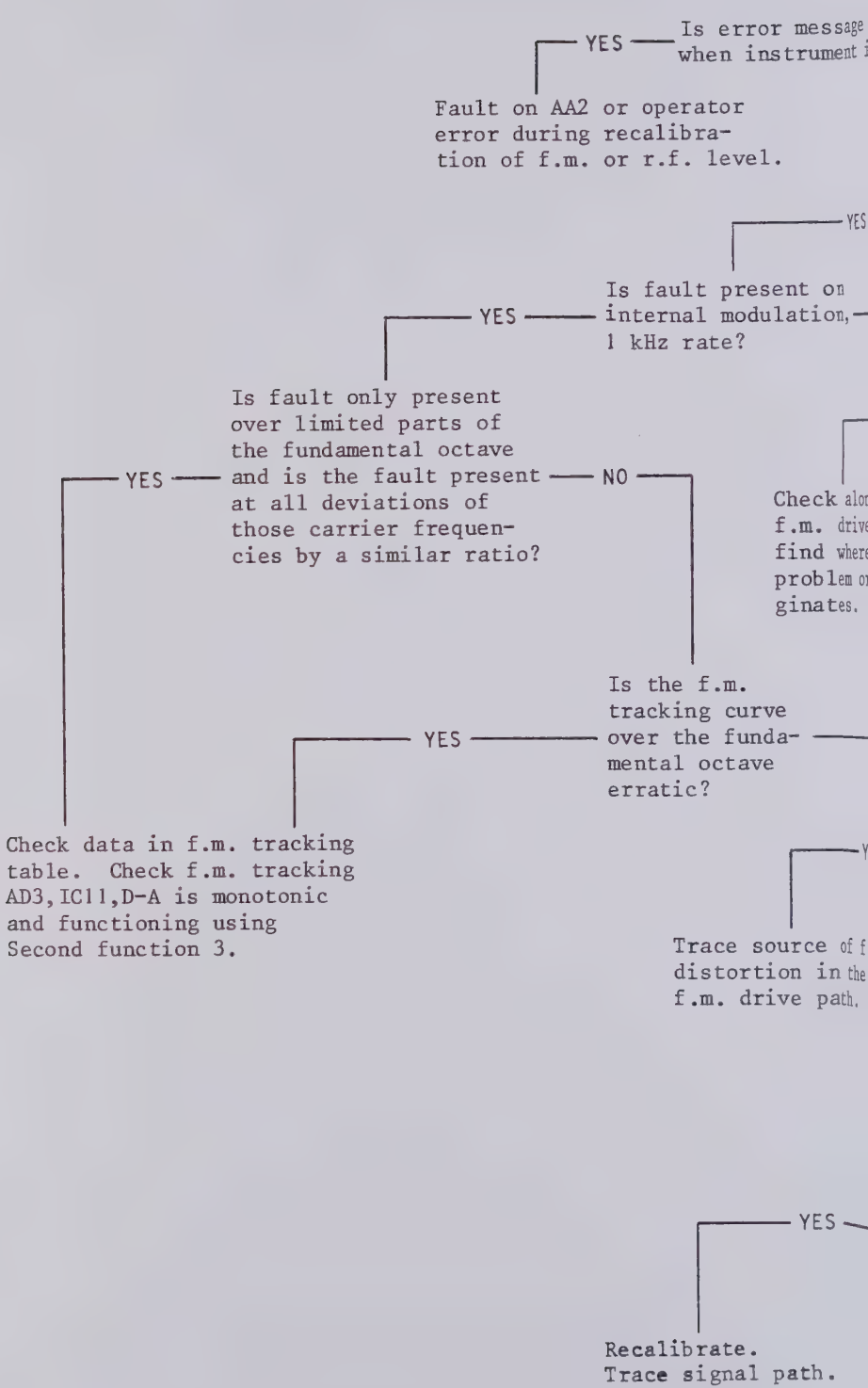
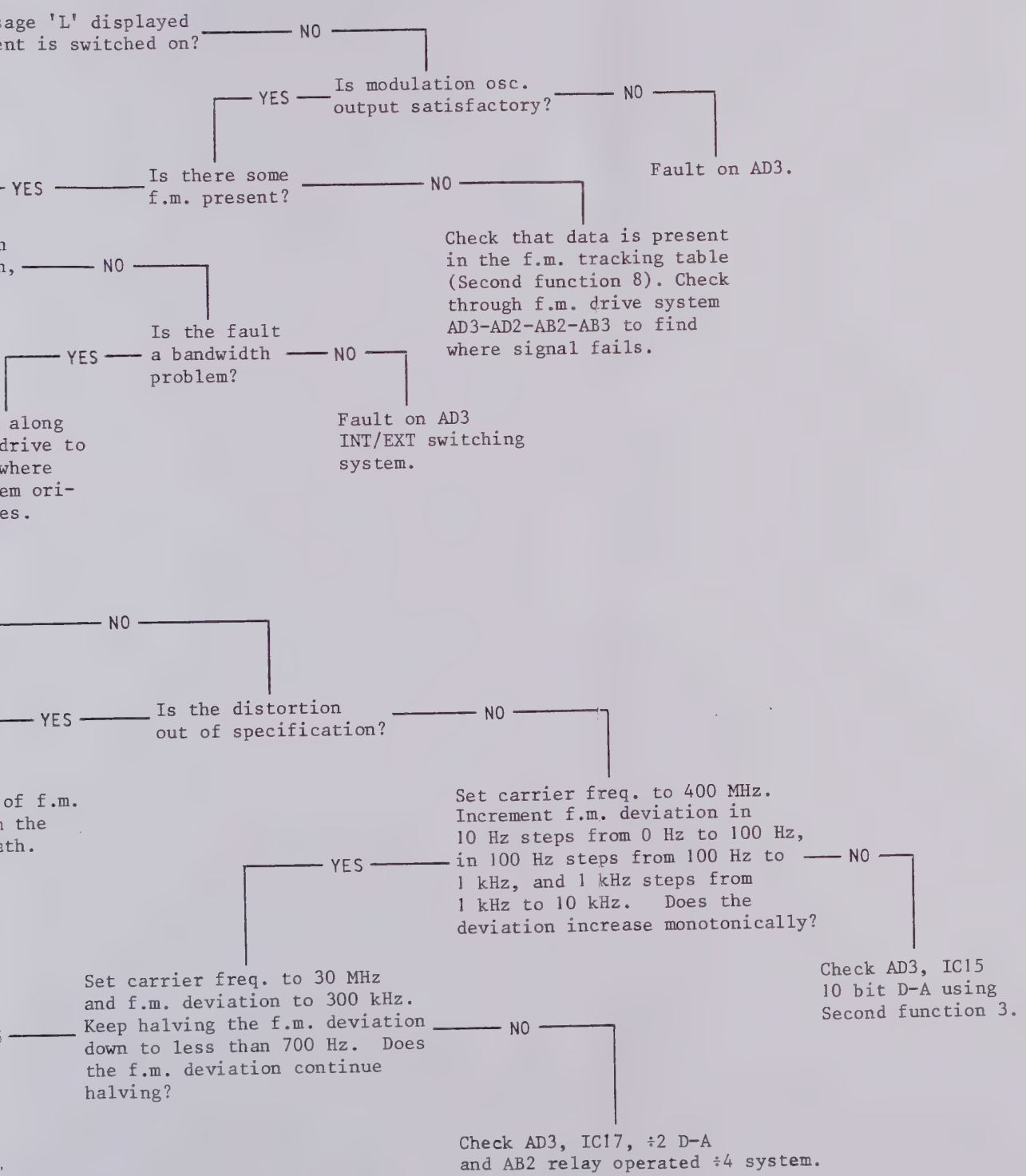

YES
Is error message
when instrument
Fault on AA2 or operator error during recalibration of f.m. or r.f. level.
YES
Is fault present on internal modulation, 1 kHz rate?
YES
Is fault only present over limited parts of the fundamental octave and is the fault present at all deviations of those carrier frequencies by a similar ratio?
NO
Check alon
f.m. drive
find where
problem or
ginates.
YES
Is the f.m. tracking curve over the fundamental octave erratic?
YES
Check data in f.m. tracking table. Check f.m. tracking AD3, IC11, D-A is monotonic and functioning using Second function 3.
Trace source of f
distortion in the
f.m. drive path.
YES
Recalibrate.
Trace signal path.

*TABLE 10 FM FAULT*


age 'L' displayed
nt is switched on?
NO
Is modulation osc. output satisfactory?
NO
YES
Fault on AD3.
YES
Is there some f.m. present?
NO
Check that data is present in the f.m. tracking table (Second function 8). Check through f.m. drive system AD3-AD2-AB2-AB3 to find where signal fails.
NO
Is the fault a bandwidth problem?
NO
YES
Fault on AD3 INT/EXT switching system.
along drive to where em ori- es.
NO
Is the distortion out of specification?
NO
YES
of f.m. the th.
Set carrier freq. to 400 MHz. Increment f.m. deviation in 10 Hz steps from 0 Hz to 100 Hz, in 100 Hz steps from 100 Hz to 1 kHz, and 1 kHz steps from 1 kHz to 10 kHz. Does the deviation increase monotonically?
NO
YES
Check AD3, IC15 10 bit D-A using Second function 3.
Set carrier freq. to 30 MHz and f.m. deviation to 300 kHz. Keep halving the f.m. deviation down to less than 700 Hz. Does the f.m. deviation continue halving?
NO
Check AD3, IC17, ÷2 D-A and AB2 relay operated ÷4 system.

Residual f.m. problems

52. This section provides guidance for identifying the source of residual f.m. problems. No fault finding algorithm is provided. Residual f.m. problems are usually the result of spurious modulation of the oscillators in the upper r.f. box. The internal frequency standard should be checked first for spurious modulation. The most sensitive oscillator is the bank of four oscillators on AB3 (only one is in use at any given time) whose varactor diode sensitivity can be up to 10 MHz/V. Even very low level signals can cause spurious signals.

53. If the spurious signal is related to the mains frequency check that the d.c. power supplies do not have high levels of ripple. Typically the +5 V supply has 100 μV of 100 Hz (or 120 Hz) and the +15, -15 and +24 V supplies have 30 μV or less. Check that the regulators on AB4 (+11.5 and -11.2) are within 12% of their nominal value. Check that the +5 V regulator IC1 on AA0 is operating correctly.

54. Instability in a phase locked loop can cause coherent spurious signals to be generated. This can be checked by observing the varactor diode voltages on AA1, AB5 and AB4 with an a.c. coupled oscilloscope and checking for coherent signals. Phase locked loop instability will normally produce significant signal excursions while maintaining the average frequency of the loop at the correct frequency. It should be noted that the input to the oscilloscope must be a.c. coupled since the loading of even quite high impedances (10 MΩ) can result in the phase detector having to produce a significant output at the phase detector rate.

55. The output phase locked loop can be made unstable in the f.m. off mode if the loop filter control lines on AB4 and AB3 are not operating correctly. A similar problem can exist in the f.m. on mode but normally one of the modes will operate if the fault is due to the loop filter control lines. Phase locked loop instability, where the average output frequency is correct, but the frequency is very unstable, is most likely to be caused by faulty components in the analogue part of the phase detector where the output current pulses are directed to the loop filter and the resulting d.c. is fed to the varactor diodes.

56. If the amount of residual f.m. is small (though not out of specification) and no obvious fault can be found the problem may originate in AB3. More fault finding data for AB3 is given in the board level fault finding section.

RPP failure

57. The RPP system uses a reed to protect the output of the attenuator from the accidental application of reverse power (d.c. or r.f. power). The RPP can be tested by applying ±5 V d.c. to the r.f. output connector. If the l.e.d. in the RF LEVEL key flashes and the REV PWR LIMIT annunciator is set but the RPP delay does not go open circuit, first check to see if the yellow l.e.d. D10, on AT2 is on. If it is on this indicates that although the detector has alerted the keyboard the RPP delay has been left on and the fault is on AT2. If D10, AT2 is not on check that the voltage on C1, AT0 is at approximately 0 V. If it is, relay assembly RLF, AT1 has been damaged.

58. If applying ±5 V to the r.f. output fails to produce a front panel response and the RPP relay remains closed check that approximately 0.75 V is present on C2, AT0 if +5 V has been applied, or that -0.75 V appears on C3,

AT0 if -5 V is applied. If this voltage is not present the fault is on AT1 and if the voltage is present the fault is on AT2.

59. If the front panel does not respond but the RPP relay is open circuit this will indicate that the control line from AT2 to the keyboard AD4 is not operating the electronic switch on AD4 and the fault can be traced from AT2 to AD4 via AD2.

60. If the front panel responds as soon as the instrument is switched on and without reverse power being applied, this indicates that there is a fault in the detector system on AT0 or the RPP is not being reset when the instrument is switched on. The RPP reset line can be traced using second function 3. It should be noted that if AD3 is not plugged into its edge connector, the RPP will not be reset because the attenuator address latch (A6L10) is decoded on AD3.

## BOARD LEVEL FAULT FINDING

61. The following section gives guidance on fault finding at board level. Where appropriate, guidance is given on how to fault find on the printed board; the control data generated by the microprocessor; information on the waveforms that can be expected at various points on the circuit, and how to realign the board before recalibrating the instrument.

### AA1 : LSD loop

62. AA1 includes a complete phase locked loop and an additional variable ratio divider (VRD). Phase locked loop faults can be traced by checking each element in the system i.e., the oscillator, the VRD and the phase detector.

63. First check that the oscillator is working (not necessarily at the correct frequency) by monitoring TP1. In a functioning loop, its frequency will be between 10 and 19.999 MHz. A fault elsewhere on the board may result in the frequency being incorrect in which case the voltage on TP2 should be checked to see if it is giving the expected varactor voltage for the observed oscillator frequency. If the frequency on TP1 is correct the fault will be the VRD formed by IC10 - IC17 and fault finding can be carried out in the same way as when fault finding on the phase locked loop's VRD.

64. If the oscillator is functioning correctly but is not at the correct frequency, check the division ratio of the VRD by measuring its input and output frequency and calculating the ratio. If the VRD is at fault check that the data latched by IC8 and IC9 is correct. If no fault is found check that each of the counters IC3 to 7 have clock input pulses on pin 2 and that the QA and QD outputs (pins 14 and 11) have pulses which reduce in frequency by factors of approximately 10 as the signal progresses down the counter chain. Failure of a device to produce these pulses would indicate that either the $\overline{\text{RESET}}$ line is low (fault IC16) the relevant IC is faulty or there is a fault with the carry out pulse from pin 15 of the previous counter IC.

65. If the VRD is not at fault check the phase detector circuit for faults. As a further aid to fault finding the mini-jump linking TP3,4 may be removed and a variable positive voltage applied to TP4 in order to directly control the oscillator frequency. If the oscillator frequency (on TP1) is adjusted just above the correct frequency, TP2 should be pulled down to 0.2 V by the phase detector. If the frequency is pulled too low then TP2 should be driven to 14.8 V by the phase detector.

66. Control data AA1. To calculate the control data for AA1 first calculate the carrier frequency generated by AB3 using the block diagram. This will equal the output frequency if it is between 260.00001 MHz and 520 MHz. Consider the frequency to be ABC.DEFGH MHz. Data sent is then as shown in Table 11 below.

*TABLE 11 CONTROL DATA AA1*

| *Latch address* | *IC numbers* | *Data Lines* | *Data* |
|---|---|---|---|
| A6L0 | IC11 | D0-D3 | Second m.s.b. of (10000 - ABCD)<br>m.s.b. of (10000 - ABCD) |
| A6L1 | IC10<br>IC10 | D0-D3<br>D4-D7 | 1.s.b. of (10000 - ABCD)<br>Second 1.s.b. of (10000 - ABCD) |
| A6L2 | IC9<br>IC9 | D0-D3<br>D4-D7 | Nines complement of F<br>Nines complement of E |
| A6L2 | IC9<br>IC8 | D0-D3<br>D4-D7 | Nines complement of F<br>Nines complement of G |

67. Test data AA1.

TP1 Output from 1.s.d. oscillator. Frequency between 10 and 20 MHz. Waveform amplitude is typically 5 V p-p at 10 MHz and 4 V p-p at 19.999 MHz.

TP2 Varactor voltage for 1.s.d. oscillator. DC level 2.28 V at 10 MHz, 10.1 V at 19.999 MHz.

TP3,4 Mini jump may be removed and a d.c. voltage applied to TP4 to control the 1.s.d. oscillator while fault finding.

TP5,6,7,8 Used by Marconi Instruments Autotest only.

IC16, pin 9 Normally high with a 50 ns pulse to low state with a p.r.f. of 1 kHz if the 1.s.d. loop is working. An additional very narrow pulse may be present 400 to 800 ns previous to this pulse - this is not a fault.

IC7, pin 14 Pulse waveform with p.r.f. of 1 kHz. Mark to space ratio is variable, being low for 100 ns when the 1.s.d. is at 10 MHz and approximately a square wave.

IC1, pin 11 Pulse waveform 1 kHz p.r.f.

IC1, pin 5 When phase locked normally high with low 60 ns pulses at a p.r.f. of 1 kHz. If 1.s.d. loop oscillator frequency is high (not phase locked) it should produce wider pulses to try to pull the oscillator frequency lower.

IC1, pin 8 When phase locked normally low with high 50 ns pulses at p.r.f. 1 kHz. If the 1.s.d. loop oscillator frequency is low (not phase locked) it should produce wider pulses to try to pull the oscillator frequency higher.

AA2 : Microprocessor system

68. The board AA2 contains the microprocessor controller and an interconnection system for distributing control data. All the complex IC's on this board are plugged into IC sockets in order to aid fault finding. Without these sockets fault finding can be difficult because of the complex nature of the operations undertaken on this board. If the error message "H" is displayed at switch-on this indicates a RAM fault in either IC3 or IC7. If the error message "P" is displayed at switch-on this indicates a fault in the PROM set IC13,14,15 or 16. This set of IC's is normally replaced as a set. Faulty IC sockets, breaks or shorts in tracks may also lead to error messages being displayed if they result in the RAM/PROM being incorrectly read. If error message "L" is displayed the calibration data in the EAROM store has changed and does not agree with the check sum. This would indicate a faulty EAROM or that the -30 V supply is being incorrectly switched during switch-on or off.

69. Failure to display an error message does not eliminate RAM or PROM faults if the microprocessor is unable to run the system. If no obvious fault can be found (e.g. IC's running hot) first check that there is a clock signal on IC1 pin 7. If there is not check for loading effects by removing the mini-jump from TP7,8 and then try replacing IC1 and XL1. If no fault can be found try replacing each IC in turn until the cause can be found.

70. Faults confined to the EAROM store should be investigated by first checking that the -30 V supply to the EAROM, IC8, is operated during a store operation. Also check that at switch-on and switch-off the -30 V line is not turned on. If these tests are satisfactory replace IC8 and re-calibrate the instrument. The replacement EAROM will have to be initialized as described in the calibration section.

71. Test data AA2.

| | |
|---|---|
| IC1, pin 37 | Microprocessor clock 3.072 MHz. |
| IC7, pin 35 | Normally low. When completing a store operation it should go intermittently high (and sometimes tri-state) in order to turn on the -30 V supply to IC8. |
| IC9, pin 12 | Normally at -15 V. When completing a store operation it should oscillate between -15 V and ground. |
| IC9, pin 2 | Normally at 0 V. On completing a store operation it should oscillate between 0 and -15 V. |
| TR5 collector | Normally at 0 V. When completing a store operation it should oscillate between +5 and -15 V. |
| TR4 emitter | Normally at -15 V. When completing a store operation it falls to -30 V. |
| IC8, pin 1 | Normally at +5 V. On completing a store operation it falls to -30 V intermittently. |

AA3 : Frequency standard

72. Control data AA3. The control data for AA3 is latched on AA2 as shown in Table 12 below.

*TABLE 12 CONTROL DATA AA3*

| *Latch address and data line* | *PLBP pin no.* | *Data* |
|---|---|---|
| A6L5 D4 | 5 | Logic high if INT STD.<br>low if EXT STD. |
| A6L5 D6 | 10 | Logic high if output frequency is >2.03125 MHz. |

73. Test data AA3.

| | |
|---|---|
| IC1, pin 4 | On INT STD 3 V p-p 10 MHz standard.<br>On EXT STD logic low. |
| IC1, pin 5 | High for INT STD.<br>Low for EXT STD. |
| IC2, pin 10 | On INT STD t.t.l. level 10 MHz signal.<br>On EXT STD logic low. |
| IC3, pin 3 | TTL level 10 MHz signal. |
| IC3, pin 9 | TTL level 100 kHz signal. |
| IC4, pin 9 | TTL level 1 kHz signal. |
| IC2, pin 4 | For carrier frequencies from 2.03126 MHz logic low.<br>For carrier frequencies up to 2.03125 MHz t.t.l. level 10 MHz signal. |
| R8,R9 junction | Nominal sine wave 0.6 V p-p. |
| PLBP, pin 14 | Nominal sine wave 0.6 V p-p with spurious amplitude modulation caused by the v.c.x.o. frequency on AB5. |

AB1 : Output v.r.d.

74. If a fault on AB1 has been diagnosed first check that the r.f. voltage on the collector of TR1 is correct. If the fault results in there being no output from PLBU this normally indicates a catastrophic failure of one of the components in the divider chain. Use an oscilloscope to check that there is a clock pulse on TP1. If there is not this indicates a fault in one of the dividers IC1, IC2 or the buffer stage IC3a. Then use the oscilloscope to check that the QA and QD outputs of IC7,8,9 are toggling. If none are toggling check that TP3 is generally high. If it is not, this indicates a fault in the subsidiary counter system formed by IC11,12. If TP3 is high and none of the IC's toggle the fault is likely to be in IC7.

75. If the VRD is functioning and the division ratio is controllable (though the ratio is wrong) check that the correct data has been latched on IC4,5. If the incorrect division ratio seems to be related to one decade of the division ratio only, replace the respective counter (IC6 for 100 kHz decade, IC7 for 1 MHz decade, IC8 for 10 MHz decade and IC9 for 100 MHz decade of the fundamental frequency). When the 100 kHz decade (IC6) is suspected it is possible that a fault exists in the 10 or 11 divider, IC2, or its associated control circuit.

76. If the VRD produces an output signal but the division ratio is not controllable this indicates a fault in one of the devices that reset the counter chain. Check that all the inputs to IC12 are toggling and that periodically there is an output pulse on TP4 which enables the subsidiary counter IC11.

77. Control data AB1. AB1 uses two latch addresses to recieve control data. These addresses are identical with two addresses on AA1. As with AA1 assume the output frequency from AB3 is of the form ABC.DEFGH MHz where ABCD is between 2600 and 5200. The data sent to AB1 is then as shown in Table 13 below.

*TABLE 13 CONTROL DATA AB1*

| *Address* | *IC No.* | *Data lines* | *Data* |
|---|---|---|---|
| A6L0 | IC5 | D4 - D7<br>D0 - D3 | MSB of (10000 - ABCD)<br>Second m.s.b. of (10000 - ABCD) |
| A6L1 | IC4 | D4 - D7 | Third m.s.b. of (10000 - ABCD)<br>LSB of (10000 - ABCD) |

78. Test data AB1.

| | |
|---|---|
| TR1 collector | 0 dBm signal at fundamental frequency. |
| TP1 | TTL level signal. Frequency approx. 13 to 26 MHz according to fundamental frequency set. |
| TP2 | TTL level. Normally high with a low pulse of between 0 ns (non existent) and 750 ns according to the fundamental frequency set and the setting of the l.s.d. (100 kHz decade of fundamental freq.) of VRD setting. |
| TP3 | TTL level. Normally high with low pulse of 75 ns to 150 ns duration according to fundamental frequency setting. |
| TP4 | TTL level. Normally low with two high pulses close together. The first and only significant pulse is between 40 ns and 80 ns wide according to the fundamental frequency. Frequency is approximately 50 kHz. |
| TP5 | For Marconi Instruments Autotest use. |
| IC9, pin 12 | TTL level. Output from VRD. Frequency approx. 50 kHz. |

AB2 : Divide-by-two chain and f.m. drive

79. The r.f. divide-by-two system on AB2 is generally straightforward. A fault will normally result in a failure to frequency divide the signal over one or more octaves and either produce the wrong output frequency or no output at all. The fault will normally be found in the highest frequency circuit that fails to operate correctly. Check that when the fault occurs the data latched by IC8 is correct and check the input and output circuits of the divide-by-two that normally generates the required octave of frequency. The relevant dividers are listed below :

| *Output frequency range* | *Output IC No.* |
|---|---|
| 260-520 MHz | - |
| 130-260 MHz | 1 |
| 65-130 MHz | 2 |
| 32.5-65 MHz | 3 |
| 16.25-32.5 MHz | 4 |
| 8.125-32.5 MHz | 4 |
| 4.0625-8.125 MHz | 5 |
| 2.03125-4.0625 MHz | 5 |

If all frequencies below 130 MHz are affected, check that IC6 is not faulty.

80. Control data AB2. Two sets of control data are required for AB2. The data sent to the octal latch IC8 control the circuits that divide the output from AB2 by factors of two as shown in Table 14 below.

*TABLE 14 DIVIDE-BY-TWO CONTROL DATA AB2*

| *Output frequency of instrument (MHz)* | *Data sent to latch A6L4 IC8 of AB2* D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| 1040 - 520.00002 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 520 - 260.00001 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 260 - 130.00001 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 130 - 65.00001 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 65 - 32.50001 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 32.5 - 16.25001 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 16.25 - 8.12501 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 8.125 - 4.06251 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 4.0625 - 2.03126 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0.08 - 2.03125 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

81. The second set of control data is required to provide range data for the f.m. drive circuits. From the f.m. deviation the instrument is set to first calculate the f.m. deviation required from AB3. This calculated deviation has to take into account the fact that if AB2 has to be set to

divide the frequency from AB3 then it will also divide the f.m. deviation. The frequency multiplier in 2019 that generates the 520 to 1040 MHz band doubles the f.m. deviation and the b.f.o. band of 0.08 - 2.03125 MHz is generated from 10 to 12 MHz. From this deviation, called the fundamental deviation, the control data required is as shown in Table 15 below.

*TABLE 15 RANGE CONTROL DATA AB2*

| *Fundamental deviation (kHz)* | *Data sent to A6L6 IC9 of AB2* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *D7* | *D6* | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* |
| 1280 - 5200 | * | * | * | * | * | 1 | 1 | 1 |
| 320 - 1280 | * | * | * | * | * | 1 | 1 | 0 |
| 80 - 320 | * | * | * | * | * | 1 | 0 | 0 |
| 0 - 80 | * | * | * | * | * | 0 | 0 | 0 |

Note * indicates a "don't care" state.

82. Test data AB2.

TR1 collector — Approximately 0 dBm at fundamental frequency.

TR2 emitter — For output freq. >260 MHz signal level -14 dBm.
For output freq. <260 MHz signal level 0 dBm with some sub-harmonics present.

IC1, pin 7 — For output freq. >130 MHz signal level less than -20 dBm.
For output freq. <130 MHz signal level 0 dBm covering octave 130 MHz to 260 MHz. Some sub-harmonics present.

TR8 base — For output freq. <130 MHz signals are at -15 dBm.
For output freq. 130 to 260 MHz signal -5 dBm.
For output freq. >260 MHz only low level signals.

PLCJ, pin 2 — With carrier frequency 520 MHz, f.m. deviation 5.2 MHz at 1 kHz rate. Audio signal typically 8 V p-p.
As above at 2.6 MHz deviation audio signal 4 V p-p.
As above at 1.2 MHz deviation audio signal 7.7 V p-p.

AB3 : RF oscillators

83. Faults on AB3 which result in one or more of the oscillators not operating can generally be found by first identifying which oscillator is at fault and then checking the d.c. bias conditions of the active and off oscillators. If the active device is not at fault it will be necessary to check or replace each element of the tuned circuit.

84. Residual f.m. problems are generally more difficult to find. There are many possible causes but the most likely ones are noisy varactors, noisy transistors or intermittent capacitors. The decoupling capacitors C9,C10,C25,C26 can cause residual f.m. problems even when the oscillator to which they are connected is not on. This is because they cause an additional coupling diode,

D3, D4, D10 or D11 to be partially turned on.

85. Microphony can be caused if the inductors L1,L2,L5,L6,L7,L8,L11,L12 are not securely varnished to the printed circuit board.

86. Test data AB3

| | |
|---|---|
| SKDL | (Output from pin 1). Output level varies from approximately -3 dBm to 2 dBm according to fundamental frequency selected. Frequency is that of the fundamental octave. |
| C112 | (Input from pin 1). Between 3 V and 15 V according to the frequency selected. |
| TR6 base | Approximately 6 dBm varying with fundamental octave frequency. |
| TR11 collector | Approximately -3 dBm. May have significant levels of harmonics present. |

87. The following data applies with a carrier frequency of 520 MHz set:

| | |
|---|---|
| TR2 collector | 11.5 V d.c. |
| TR4 collector | 11.5 V d.c. |
| TR7 collector | 11.5 V d.c. |
| TR9 collector | 8.5 V d.c. |

88. Realignment data AB3. Each of the 4 oscillators incorporates a sliding link on its tuning inductor which may be used to set up the oscillator. During adjustment the heat of the soldering iron used to move the link will cause some reaction from the oscillator frequency. Excessive heating should be avoided in order to avoid long settling times.

(1) On oscillator 1, adjust the sliding link such that at an output frequency of 260.00001 MHz, the voltage on tag 2, is nominally 3.6 V without the lid of the oscillator on.

(2) On oscillator 2, adjust the sliding link such that at an output frequency of 309.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.

(3) On oscillator 3, adjust the sliding link such that at an output frequency of 368.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.

(4) On oscillator 4, adjust the sliding link such that at an output frequency of 437.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.

AB4 : Output phase detector

89. Digital faults on AB4 are generally easy to find using the test data provided. If necessary the mini-jump linking TP6,7 can be removed and a voltage applied to TP7 to control the oscillators on AB3, but most faults can be found without using this method. Faults in the digital part of the phase comparator are also relatively easy to find.

90. If the fault is in the analogue part of the phase detector first check all the d.c. voltages given in the test data. If the fault has not been located, remove the mini-jump and connect 0 V to TP7. IC5, pin 8 should produce pulses which will pull TP7 to 18 V. Check that this happens. If it does not, the fault is in the current pulse generator (TR12 to TR23) part of the phase detector. Repeat the test while applying 15 V to TP7. IC5, pin 6 should generate pulses which pull TP6 down to -8 V.

91. Diagnosing which transistor in the current pulse generator is at fault can be time consuming and as a result, it is often quicker to replace all the transistors.

92. If the phase locked loop sets the output frequency to approximately the correct value but the frequency is unstable, check that the p.l.l. filter control lines are working. If the fault cannot be found, replace the components in the loop filter. If TR6 develops a drain to source short circuit it may result in TR25 developing excessive input leakage current (because of impact ionization) and cause excessive phase detector breakthrough on the output carrier signal.

93. Control data AB4. The control data for AB4 is latched on the microprocessor board AA2. The latch address is A6L5. It should be noted that the latch address A6L5 also controls the frequency standard on AA3.

| *PLBY Pin No.* | *Line* | *Data* |
|---|---|---|
| 3 | LD0 | High for fundamental frequencies of 260.00001 to 309 MHz. |
| 12 | LD1 | High for fundamental frequencies of 309.00001 to 368 MHz. |
| 4 | LD2 | High for fundamental frequencies of 368.00001 to 437 MHz. |
| 11 | LD3 | High for fundamental frequencies of 437.00001 to 520 MHz. |
| 5 | LD5 | High if f.m. is not on. |

If data to latch A6L5 is being sent under second function control ensure that the data sent on D4 and D6 is also correct (see AA3).

94. Test data AB4

| | |
|---|---|
| IC1, pin 8 | TTL signal. Approx. 50 kHz square wave. |
| IC4, pin 8 | TTL signal. FM OFF. Approx. 50 kHz square wave.<br>FM ON. Approx. 10 kHz signal. |
| IC4, pin 6 | TTL signal. If output loop is locked then with f.m. off p.r.f. is approx. 50 kHz, and with the f.m. on it is 10 kHz. |
| IC5, pin 9 | TTL signal. Normally high with a 50 ns low pulse at p.r.f. of approx. 50 kHz (FM OFF) or 10 kHz (FM ON). If the loop is out of lock and the oscillator (AB3) frequency is low, wider pulses should be produced to increase the oscillator frequency. |
| IC5, pin 6 | TTL signal. Normally low with a 50 ns high pulse at a p.r.f. of 50 kHz (FM OFF) or 10 kHz (FM ON). If the loop is out of lock and the oscillator frequency is high, wider pulses will be produced to decrease the oscillator frequency. |
| TR10 collector | With FM ON : 0 V.<br>FM OFF : -11.2 V. |
| TR9 collector | With FM OFF : 0 V.<br>FM ON : -11.2 V. |
| TP1 | DC level approx. 17.5 V. When locked and the f.m. is off it has a 1 V positive pulse 50 ns wide. With the f.m. on the pulse should disappear. |
| TP2 | DC level approx. -8 V. When locked and the f.m. is off it has a 0.7 V negative pulse 50 ns wide. No pulse when f.m. is on. |
| TP3 | DC level approx. 17.5 V. When locked it has a 1 V positive pulse 50 ns wide with a p.r.f. of 50 kHz with the f.m. off and 10 kHz with the f.m. on. |
| TP4 | DC level approx. -8 V. When locked it has a 0.7 V negative pulse 50 ns wide with a p.r.f. of 50 kHz with the f.m. off and 10 kHz with the f.m. on. |
| TP6,7 | Mini-jump may be removed to control the oscillators on AB3 directly by applying a variable d.c. voltage to TP7. |

AB5 : Voltage controlled crystal oscillator (v.c.x.o.) loop

95. AB5 contains the complete v.c.x.o. phase locked loop. There is a potential latch up condition which can occur only under fault conditions, whereby the phase locked loop can lock to a frequency less than 10 MHz. To avoid any possible confusion it is often easier to fault find with the mini-jump linking TP2,3 removed and the v.c.x.o. frequency controlled by a voltage applied to TP3.

96. An unusual fault can be caused if the capacitor C19 is open circuit. The spurious pick-up on pin 7, IC5, can cause multiple transitions on the output of IC6a and result in erratic failure to lock. This fault can be diagnosed by checking the output from IC6a for spurious edges on pulse transitions.

97. Test data AB5.

| | |
|---|---|
| TR1 collector | Distorted 3 V p-p signal. When phase locked frequency is between approx. 10.002 and 10.008 MHz (v.c.x.o. freq.). |
| TP1 | TTL signal. VCXO frequency. |
| TR8 collector | Distorted signal at v.c.x.o. frequency 1 V p-p. |
| IC2, pin 1 | 10 MHz sine wave 0.6 V p-p. Some spurious a.m. from the v.c.x.o. frequency. |
| IC2, pin 6 | DC level 9 V. Audio signal approximately 1.5 V p-p. Frequency (when locked) of approx. 2 to 8 kHz. |
| IC5, pin 3 | Audio signal about ground. Approx. 1.5 V p-p. |
| IC5, pin 7 | Square wave signal 5 V p-p. TTL compatible, freq. approx. 2 to 8 kHz. |
| IC4, pin 3 | TTL signal. Freq. of 2 to 8 kHz. |
| IC4, pin 11 | TTL signal. Freq. 2 to 8 kHz if v.c.x.o. is locked. |
| IC4, pin 8 | TTL signal. Normally low with a 60 ns positive pulse. If the v.c.x.o. frequency is too low it produces wider pulses to pull the v.c.x.o. frequency lower. |
| IC4, pin 5 | TTL signal. Normally high with a negative 60 ns pulse. If the v.c.x.o. frequency is too high it produces wider pulses to pull the v.c.x.o. frequency higher. |
| TP4 | With carrier frequency set to 520 MHz (v.c.x.o. approx. 10.002 MHz) d.c. level 3.6 V.<br>With carrier frequency set to 260.09999 MHz (v.c.x.o. approx. 10.008 MHz) d.c. level 10 V. |
| TP2,3 | Mini-jump may be removed and an external d.c. voltage applied to TP3 to control the v.c.x.o. frequency. |

AC2 : Beat frequency oscillator (BFO) system

98. Test data AC2. The following data applies at a carrier output frequency of 2 MHz.

| | |
|---|---|
| PLCU, pin 2 | 10 MHz square wave 0.6 V p-p. |
| TR1 collector | 10 MHz square wave 0.6 V p-p. |
| PLCV, pin 1 | 12 MHz sine wave 90 mV p-p. |
| TR2 collector | Very distorted signal approx. 80 mV p-p. |
| L4,L5 junction | -20 dBm 2 MHz signal and 2 V d.c. |
| PLCW, pin 3 | 4 V d.c. |
| PLCW, pin 1 | -20 dBm at 2 MHz. |

99. The following data applies at an output frequency of 10 MHz.

| | |
|---|---|
| PLCU, pin 2 | 0 V. |
| L4,5 junction | No signal. |
| PLCW, pin 3 | +0.05 V d.c. RF signal level -15 dBm. |
| PLCW, pin 1 | RF signal -15 dBm. |

AC3/13 : Filter and frequency doubler

100. Faults in the filter sections of AC3 or AC13 will usually result in the signal faults occurring over specific half octaves of frequency cover. The half octaves involved will usually give some idea of where the fault is. If the error occurs only at frequencies greater than 32.5 MHz, check the d.c. voltages at the output of IC4 against the test data. These d.c. voltages control the diodes that switch the filters. Faults in the frequency doubler section of AC13 (2019 only) can be difficult to trace because of the high frequencies involved. The recommended procedure is to first establish that the active stages are working (TR4, TR5, TR6). Check that the filter control outputs from IC7 are correct. If the fault is diagnosed as being in the filter circuits it may be necessary to replace the components one at a time, in order to find the fault. It should be noted that the earth end of R112 may be disconnected in order to improve the sub-harmonic content of the output signal at 1.04 GHz.

101. Control data AC3/13

*TABLE 16 IC2 CONTROL DATA AC3/13*

| *Output frequency (MHz)* | *Data sent to A7L4 IC2 of AC3/13* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *D7* | *D6* | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* |
| 520.00002 - 1040 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 260.00001 - 520 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 130.00001 - 260 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 65.00001 - 130 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 32.50001 - 65 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 16.25001 - 32.5 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 8.12501 - 16.25 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 4.06251 - 8.125 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 2.03126 - 4.0625 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0.08 - 2.03125 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |

| *Data line* | *Data sent to A7L5 IC3 of AC3/13* |
|---|---|
| D4 | High for frequencies less than or equal to 520 MHz (2019 only). |
| D3 | High for frequencies of 2.03126 to 1040 MHz. |
| D2 | High for frequencies of 16.25001 to 23 MHz and for frequencies of 260.00001 to 368 MHz, and for frequencies of 32.50001 to 65 MHz. |
| D1 | High for frequencies of 260.00001 to 1040 MHz, 16.25001 to 32.5 MHz and fundamental frequencies of 368.00001 to 520 MHz. |
| D0 | High for frequencies of 0.08 MHz to 32.5 MHz. |

Note : Fundamental frequency is defined as the output frequency from AB3.

*TABLE 17 IC6 CONTROL DATA AC13*

| *Output frequency (MHz)* | *Data sent to A7L6 IC6 of AC13* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *D7* | *D6* | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* |
| 520.00002 - 660 | * | * | * | * | 1 | 0 | 1 | 0 |
| 660.00002 - 820 | * | * | * | * | 1 | 0 | 0 | 1 |
| 820.00002 - 1040 | * | * | * | * | 0 | 1 | 1 | 1 |

Note : * indicates a "don't care" condition.

102. Test data AC3/13. The following data applies to conditions where the output frequency has been set to be >32.5 MHz. Measurements have been taken with a carrier frequency of 100 MHz unless otherwise stated. RF levels quoted are with the output level set to 7 dBm unless otherwise noted.

| | |
|---|---|
| TR1 base | RF level -15 dBm, nominal square wave. |
| TR2 collector | RF level -2 dBm. |
| D24 cathode | RF level -4 dBm. |
| SKCS | RF level -5 dBm. |

103. Table 18 gives a list of the expected output voltages on the open collector outputs of IC4.

*TABLE 18 DC VOLTAGES ON IC4 OUTPUTS AC3/13*

| *Carrier frequency* | *IC4 pin numbers* 2 | 4 | 12 | 10 | 8 |
|---|---|---|---|---|---|
| 1040 MHz | 15 | 15 | 15 | 15 | 0.13 |
| 520 MHz | 0.15 | 4.81 | 4.37 | 9.16 | 11.67 |
| 260 MHz | 15 | 0.15 | 5.18 | 2.87 | 10.79 |
| 130 MHz | 15 | 15 | 15 | 0.15 | 7.86 |
| 65 MHz | 15 | 15 | 15 | 15 | 0.13 |

104. The following data applies to conditions where the output frequency has been set to <32.5 MHz. Measurements generally refer to a carrier of 10 MHz unless otherwise stated.

| | |
|---|---|
| TR3 collector | RF level -14 dBm. |
| PLCT | RF level -15 dBm. |

105. The following data applies to AC13 (2019) only.

| | |
|---|---|
| C110 | Carrier 530 MHz -5 dBm, sub-harmonic -24 dB.<br>Carrier 1040 MHz -3 dBm, sub-harmonic -10 dB. |
| TR5 collector | Carrier 530 MHz 3 dBm, sub-harmonic -27 dB.<br>Carrier 1040 MHz 0 dBm, sub-harmonic -7 dB. |
| TR6 base | Carrier 530 MHz -8 dBm, sub-harmonic -40 dB.<br>Carrier 1040 MHz -9 dBm, sub-harmonic -33 dB. |

106. Realignment procedure. Connect an r.f. signal source to PLDF, level -11 dBm.

*LF Channel :*

Monitor output from PLCT (providing a 200 Ω load impedance). Select each of the low-pass filters in turn by keying-in the SET FREQ on the 2018/19 keyboard, and check the PASS BAND ripple and relative attenuation at the 2*f (min) FREQ.

Nominal output level : 40 mV (r.m.s. p.d.) into 200 Ω *
PASS BAND ripple : not greater than 4 dB
2*f (min) level : Better than -18 dBc for 32.5 - 4.0625 MHz, better than -15 dBc for 4.0625-2.03126 MHz.

*TABLE 19 LF LOW-PASS FILTER ALIGNMENT (1-32 MHz)*

| *SET FREQ MHz* | *PASS BAND MHz* | *2*f (min) FREQ MHz* |
|---|---|---|
| 32 | 23 - 32.5 | 46 |
| 23 | 16.25 - 23 | 32.5 |
| 16 | 11.5 - 16.25 | 23 |
| 11 | 8.125 - 11.5 | 16.25 |
| 8 | 5.75 - 8.125 | 11.5 |
| 5 | 4.0625 - 5.75 | 8.125 |
| 4 | 2.875 - 4.0625 | 5.75 |
| 2.8 | 2.03126 - 2.875 | 4.0625 |

Monitor the output from PLCR pin 1 (200 Ω load impedance) to check the output to the b.f.o. board. Same conditions as above.

| *SET FREQ MHz* | *PASS BAND MHz* | *2*f (min) FREQ MHz* |
|---|---|---|
| 2 | 11.5 - 12.03125 MHz | 23 |
| 1 | 10.08 - 11.5 | 20 |

*NOTE : If 200 Ω load is made up by including a 150 Ω resistor in series with the 50 Ω input of the measuring instrument a 12 dB insertion loss will be introduced. This will result in a level of 10 mV across 50 Ω, or -27 dBm.

*HF Channel :*

107. Monitor output from SKCS (load impedance 50 Ω). Tests similar to those for the LF Channel are performed, but the HF Channel filters need to be individually adjusted to meet the following conditions :

Nominal output level : -6 dBm
PASS BAND ripple : not greater than 4 dB
2*f (min) level : better than -20 dBc.

(1) To trim the 520 and 368 MHz low-pass filters, unsolder sliders on printed coils and re-position as required. (There is no need to switch off the power supplies.) Moving the sliders towards the filter capacitors will reduce the inductance and so raise band edge frequency. Providing the PASS BAND ripple and 2*f (min) level are correct the actual band edge frequency is unimportant.

(2) To trim the "turret" low-pass filters, start with the ferrite slugs flush with the turret tops. Wind the slug in the lower numbered coil downwards until the filter band edge drops by 1 dB; then unwind 1 full turn. Repeat this operation for the second coil. Finally check the

conditions above and make further minor adjustments as necessary.

*TABLE 20 HF LOW-PASS FILTER ALIGNMENT (46-520 MHz)*

| *SET FREQ MHz* | *PASS BAND MHz* | *2*f (min) FREQ MHz* |
|---|---|---|
| 520 | 260 - 520 | 736 ** |
| 368 | 260 - 368 | 520 |
| 260 | 184 - 260 | 368 |
| 184 | 130 - 184 | 260 |
| 130 | 92 - 130 | 184 |
| 92 | 65 - 92 | 130 |
| 65 | 46 - 65 | 92 |
| 46 | 32.5 - 46 | 65 |

** NOTE : 520 MHz low-pass filter is checked down to 260 MHz (rather than 368 MHz) to ensure correct operation of frequency doubler (2019 only).

108. Frequency doubler. Monitor the output from SKCS. Select the three SET FREQ points in turn and check the level of "doubled" signal, its sub-harmonics and harmonics (up to about 1.2 GHz) across the appropriate INPUT FREQ range. The following conditions should be met for the "doubled" signal:

Nominal output level : -6 dBm (±3 dB)
Level of sub-harmonics/harmonics : Better than -35 dBc.

*TABLE 21 FREQUENCY DOUBLER AC13*

| *SET FREQ MHz* | *INPUT FREQ RANGE MHz* | *OUTPUT FREQ RANGE MHz* |
|---|---|---|
| 660 | 260 - 330 | 520 - 660 |
| 820 | 330 - 410 | 660 - 820 |
| 1040 | 410 - 520 | 820 - 1040 |

AC4 : Output amplifier

109. If, for any reason, it is necessary to remove the board AC4 from the instrument take care not to damage the integral Beryllium Oxide washer in TR10. The device is robust but it should be protected from accidental damage. If it is necessary to remove the heat sink from the stud, ensure that the nut is not overtightened. A tightening torque of 0.8 Nm is recommended by the manufacturer. See Notes and Cautions re the disposal of defective devices.

110. Control data AC4

| *Address* | *IC No.* | *Data lines* | *Data sent* |
|---|---|---|---|
| A7L1 | 4 | D0-D7 | Insertion loss control data. Binary number of between 0 and 255 provides fine control level, 255 gives minimum level and 0 gives maximum level. Data to be sent is calculated by the microprocessor from the data entered to compensate for insertion loss. |

| *Address* | *IC No.* | *Data lines* | *Data sent* |
|---|---|---|---|
| A7L2 | 6 | D0-D7 | The 8 l.s.b's of a 10 bit number used to control the r.f. output level from AC4. The 10 bit number is a number between 0 and 1000 which can control the output level with a 1 mV p.d. resolution. The number IC6 is set to is not updated until the m.s.b. is sent on A7L3. |
| A7L3 | 6 | D0-D1 | The m.s.b's of the number sent to A7L2. |
| | 2 | D6 | High for frequencies of 32.50001 to 1040 MHz. |
| | 2 | D7 | High for frequencies of 32.5 MHz or less. |

111. Test data AC4. All test data results are with the a.m. off unless otherwise stated.

| | |
|---|---|
| IC3, pin 1 | +2 V d.c. If 99% a.m. is set an audio signal should be present whose negative peaks almost reach 0 V. |
| IC3, pin 7 | DC voltage typically -1.5 V at 10 MHz, -1.2 V at 520 MHz, -0.66 V at 1040 MHz. DC level at intermediate carrier frequencies is linearly interpolated between these voltages. |
| IC3, pin 8 | DC voltage typically -2.9 V at 10 MHz, 13.4 V at 520 MHz, -4.1 V at 1040 MHz. |
| IC3, pin 14 | DC voltage at 520 MHz carrier typically 1.69 V at 7 dBm, 3.37 V at 13 dBm, 0.546 V at -2.9 dBm. |
| IC1, pin 8 | DC voltage at 520 MHz carrier typically 1.61 V at 7 dBm, 3.28 V at 13 dBm, 0.471 at -2.9 dBm. |
| IC2, pin 9 | Logic high for carriers >32.5 MHz. |
| IC2, pin 5 | Logic high for carriers <32.5 MHz. |
| TP2 | ALC voltage. Will be between 0 V and -8 V if the a.l.c. system is operating. |

AC5 : Amplitude modulator

112. If, during the course of fault finding on AC5, it is necessary to remove or replace X2 ensure that when it is replaced the metal case is soldered to the printed board in the same way as originally manufactured. Failure to do so will result in poor a.m. performance.

113. Control data AC5

| *Latch Address* | *IC No.* | *Data Lines* | *Data sent* |
|---|---|---|---|
| A7L0 | 4 | D0-D6 | 7 bit binary number between 0 and 99 corresponding to the modulation depth set in %. |
| | 2 | D7 | Single bit instruction that is set high for r.f. levels of 7.1 dBm or greater. In this mode the a.m. is set off and the mod. depth is set to 0%. |

114. Test data AC5

| | |
|---|---|
| IC4, pin 4 | With a.m. on typically 6.5 V p-p audio. |
| IC3, pin 6 | With a.m. set to 99% audio signal 5 V p-p decreasing linearly with reducing a.m. depth. |
| TR3 collector | -0.2 V for r.f. levels <7 dBm,<br>-15 V for r.f. levels >7 dBm. |
| X1, pin 1 | RF signal -6 dBm square wave. |
| X2, pin 5 | RF signal 0 dBm square wave. |
| X2, pin 1 | RF signal -18 dBm square wave. |
| TR1 collector | RF signal -12 dBm square wave. |

AD1 : Display

115. The l.c.d. units are driven by square waves which are either in phase or out of phase in order to avoid generating any d.c. component across the display. In order to fault find on parts of the circuit where the drive waveform has been converted to a square wave use a dual channel oscilloscope. Connect one input to the backplane drive on pin 1 or pin 80 of the carrier frequency display X1. Connect the second input to the point being tested and then observe the second input square wave is in phase or out of phase with the backplane drive. An in phase signal will result in a clear segment and an out of phase signal will result in a dark segment. The maintenance kit contains information on the use of the l.c.d. insertion and extraction tools.

116. Control data AD1

*TABLE 22 CONTROL DATA AD1*

| *Address* | *Data Lines* | *IC No.* | *Data sent* |
|---|---|---|---|
| A5L0 | D4-D7 | 4 | Frequency display m.s.d. |
| | D0-D3 | 5 | Frequency display second m.s.d. |
| A5L1 | D4-D7 | 6 | Frequency display third m.s.d. |
| | D0-D3 | 7 | Frequency display fourth m.s.d. |
| A5L2 | D4-D7 | 8 | Frequency display fifth m.s.d. |
| | D0-D3 | 9 | Frequency display sixth m.s.d. |
| A5L3 | D4-D7 | 10 | Frequency display seventh m.s.d. |
| | D0-D3 | 11 | Frequency display 1.s.d. |
| A5L4 | D0-D3 | 21 | Modulation display m.s.d. |
| A5L5 | D4-D7 | 22 | Modulation display second m.s.d. |
| | D0-D3 | 23 | Modulation display 1.s.d. |
| A5L6 | D4 | 27 | RF level display m.s.d. |
| | D0-D3 | 29 | RF level display second m.s.d. |
| A5L7 | D4-D7 | 30 | RF level display third m.s.d. |
| | D0-D3 | 31 | RF level display 1.s.d. |
| A5L8 | D0-D2 | 8 & 18 | Frequency display decimal point. Lines decoded as 1 out of 8. A 0 gives a decimal point to the right of the m.s.d. and this moves to the right with increasing decoded output. An output of 7 gives no decimal point. |
| | D3-D4 | 26 | Modulation display decimal point. Lines decoded as 1 out of 4. An output of 0 gives a decimal point to the right of m.s.d. and this moves to the right with increasing decoded output. An output of 4 gives no decimal point. |
| | D4-D6 | 27 | RF level display decimal point. Lines decoded as 1 out of 4. An output of 0 gives a decimal point to the right of the m.s.d. and this moves right with increasing output. An output of 3 gives no decimal points. |
| A5L9 | D0 | 3 | Frequency display REMOTE annunciator. |
| | D1 | 3 | Frequency display ADDR annunciator. |
| | D2 | 3 | Frequency display LIMIT. |
| | D3 | 3 | Frequency display MHz. |
| | D4 | 12 | Frequency display kHz. |
| | D5 | 12 | Frequency display Hz. |
| | D6 | 12 | Frequency display EXT STD. |
| | D7 | 12 | Modulation display OFF. |

*TABLE 22 CONTROL DATA AD1 (contd.)*

| *Address* | *Data Lines* | *IC No.* | *Data sent* |
|---|---|---|---|
| A5L10 | D0 | 20 | Modulation display EXT. |
| | D1 | 20 | Modulation display LIMIT. |
| | D2 | 20 | Modulation display AM. |
| | D3 | 20 | Modulation display FM. |
| | D4 | 24 | Modulation display %. |
| | D5 | 24 | Modulation display MHz. |
| | D6 | 24 | Modulation display kHz. |
| | D7 | 24 | Modulation display Hz. |
| A5L11 | D0 | 28 | RF level display OFF. |
| | D1 | 28 | RF level display REV PWR. |
| | D2 | 28 | RF level display LIMIT. |
| | D3 | 28 | RF level display - (minus sign). |
| | D4 | 32 | RF level display + (vertical bar of + sign). |
| | D5 | 32 | RF level display dBm. |
| | D6 | 32 | RF level display dB. |
| | D7 | 32 | RF level display V. |
| A5L12 | D0 | 33 | RF level display mV. |
| | D1 | 33 | RF level display µV. |
| | D2 | 33 | RF level display e.m.f. |
| | D3 | 33 | RF level display p.d. |

AD2 : Motherboard

117. Control data AD2. The data to control the 10 dB step attenuator and the RPP is latched on AD2 by IC1 address A6L10. The 10 dB step attenuator control data is as in Table 23 below.

*TABLE 23 10 dB STEP ATTENUATOR CONTROL DATA AD2*

| *Required attenuation dB* | *Data sent* | | | | | |
|---|---|---|---|---|---|---|
| | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 | 0 | 1 |
| 20 | 1 | 1 | 1 | 0 | 1 | 1 |
| 30 | 1 | 1 | 1 | 0 | 0 | 1 |
| 40 | 0 | 1 | 1 | 1 | 0 | 1 |
| 50 | 0 | 1 | 1 | 0 | 1 | 1 |
| 60 | 0 | 1 | 1 | 0 | 0 | 1 |
| 70 | 0 | 1 | 0 | 1 | 0 | 1 |
| 80 | 0 | 1 | 0 | 0 | 1 | 1 |
| 90 | 0 | 1 | 0 | 0 | 0 | 1 |
| 100 | 0 | 0 | 0 | 1 | 0 | 1 |
| 110 | 0 | 0 | 0 | 0 | 1 | 1 |
| 120 | 0 | 0 | 0 | 0 | 0 | 1 |

If the RPP is tripped it can reset by sending a logic 0 on A6L10 D0 followed by a logic 1 on the same address. Sending a logic 0 on A6L10 D0 will cause the RPP reed relay to go open circuit.

AD3 : Modulation oscillator and f.m. control

118. Control data AD3. The latch A6L15 controls the modulation oscillator and the type of modulation being used. The data sent to A6L15 is as follows:

*TABLE 24 MOD OSC CONTROL DATA AD3*

| *MOD OSC FREQ Hz* | *Data on D0-D3* | | | |
|---|---|---|---|---|
| | *D3* | *D2* | *D1* | *D0* |
| 300 | 0 | 0 | 0 | 0 |
| 400 | 0 | 0 | 0 | 1 |
| 1000 | 0 | 0 | 1 | 0 |
| 3000 | 0 | 0 | 1 | 1 |
| 6000 | 1 | 1 | 0 | 0 |
| OFF | 1 | 0 | 0 | 0 |

D4 High for internal modulation.
D5 High if f.m. is on
D6 High if the mod. a.l.c. is on
D7 High if a.m. is on

119. The latches A6L14, A6L12 and A6L13 control the f.m. deviation. The data sent is calculated by first determining the deviation required of the oscillators on AB3 after allowing for division by AB2 and frequency translation by the b.f.o. band. This deviation is referred to as the fundamental deviation. The data sent to A6L14 is given in Table 25 below.

*TABLE 25 FM DEVIATION CONTROL DATA AD3*

| *Fundamental deviation kHz* | *Data sent to A6L14 IC17 of AD3* | | | | | | | | *Multiplier* |
|---|---|---|---|---|---|---|---|---|---|
| | *D7* | *D6* | *D5* | *D4* | *D3* | *D2* | *D1* | *D0* | |
| 5120 - 5200 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.1 |
| 5120 - 2560 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 |
| 2560 - 1280 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 |
| 1280 - 640 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.8 |
| 640 - 320 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1.6 |
| 320 - 160 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2 |
| 160 - 80 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6.4 |
| 80 - 40 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.8 |
| 40 - 20 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25.6 |
| 20 - 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 51.2 |
| 0 - 10 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 102.4 |

120. The multiplier shown in the right-hand column above is used to derive the data sent to A6L12 and A6L13. If the multiplier is multiplied by the fundamental deviation in kHz the resulting number is between 0 and 1023 and can be expressed as a 10 bit binary number. This number is sent as 2 bytes. The eight least significant digits are sent to A6L12 followed by the two most significant digits to A6L13 on D0 and D1. The setting of the 10 bit D-A receiving this data, IC15, is only updated when the most significant bit is sent. The data sent to A6L11 is an 8 bit number, usually between binary 80 and 200, which is calculated from information stored in the EAROM store. Is is instrument dependent and therefore has no unique values.

121. Test data AD3

| | |
|---|---|
| D4 anode | -7.5 V d.c. |
| IC1, pin 1 | Audio signal at modulation frequency set 3.2 V p-p. |
| IC1, pin 7 | Audio signal 3.2 V p-p. |
| IC7, pin 14 | INT MOD 3.2 V p-p audio.<br>EXT MOD, audio signal corresponding to the external modulation input. |
| IC10, pin 1 | INT MOD, no signal.<br>EXT MOD, signal corresponding to external modulation input. |
| IC10, pin 7 | INT MOD, 3.2 V p-p audio signal at mod. osc. frequency.<br>EXT MOD, audio signal equal to the ext. mod. input. |
| IC6, pin 1 | Audio signal 900 mV p-p. If EXT MOD is set its level should be independent of input level for input levels of 800 mV to 1.2 V r.m.s. |
| IC8, pin 7 | 6 V p-p audio signal. |
| D2 anode | -2.6 V d.c. |
| IC8, pin 1 | DC voltage between 0 V and -8 V. Typically -5 V on INT MOD. |

122. All the following data assumes INT MOD is selected.

| | |
|---|---|
| IC9, pin 1 | With FM ON 12 V p-p audio, FM OFF - no signal. |
| IC9, pin 7 | With AM ON - typically 6.7 V p-p, AM OFF - no signal. |
| IC12, pin 6 | FM ON, carrier 520 MHz (typically) 5 V p-p audio.<br>FM ON, carrier 260.1 MHz (typically) 7.4 V p-p audio. |
| IC16, pin 6 | FM ON, carrier 520 MHz, f.m. deviation 9.9 kHz typically 4.9 V p-p audio.<br>FM ON, carrier 520 MHz, f.m. deviation 5.2 MHz typically 2.5 V p-p audio. |
| IC19, pin 6 | FM ON, carrier 520 MHz, f.m. deviation 5.2 MHz typically 9.8 V p-p audio. |

AT0 and AT1 : 10 dB step attenuator

123. Except for simple faults which do not affect the main r.f. path on AT1, it is not recommended that repairs are attempted on AT1 unless very accurate attenuator measuring equipment is available. It is generally not advisable to attempt to remove the r.f. cover over AT1, but if the cover is removed do not attempt to adjust or remove AT1 since to do so can alter the calibration of the pads. If it is established that one of the micro-switches required adjustment this can be accomplished by the following procedure:

(1) Adjust the large nylon nut so that the armature of the solenoid pulls in when between 13.5 V and 15 V d.c. is applied to the coil. The d.c. must be applied with SKLP disconnected from AT2.

(2) Energize all the solenoids except the one being adjusted.

(3) Connect a short circuit across SKAZ and an ohmmeter across SKBA. As the armature is manually closed a change of resistance should be observed when the micro-switch nearest SKBA operates. Adjust the corresponding adjustment screw so the switch operates at mid-travel.

(4) Repeat (3) with the short circuit across SKBA and the meter across SKAZ for the other micro-switch of the pad being adjusted.

(5) Lock the adjustment nut and screws with locking varnish.

AT2 : Attenuator control

124. Test data AT2

| | |
|---|---|
| IC4, pin 8 | TTL level. Normally low but on pressing the r.f. level key goes high for 40 ms. |
| TR3 collector | Normally unregulated 10 V. Goes to unregulated 25 V for 40 ms when r.f. level key is pressed. |
| IC3, pin 8 | TTL level. Low except when attempting to reset the RPP. |
| IC3, pin 2 | TTL level. Low unless reverse power has been applied. |
| IC3, pin 13 | TTL level. Low unless RPP has been tripped. |

*TABLE 26 VOLTAGES ON PLP, AT2*

| RF LEVEL | PLP pin numbers 1 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 0 dBm | 10 V | 0 V | 0 V | 0 V | 0 V | 0 V |
| -10 dBm | 10 V | 0 V | 0 V | 0 V | 0 V | 10 V |
| -20 dBm | 10 V | 0 V | 0 V | 0 V | 10 V | 0 V |
| -30 dBm | 10 V | 0 V | 0 V | 0 V | 10 V | 10 V |
| -40 dBm | 10 V | 10 V | 0 V | 0 V | 0 V | 10 V |
| -50 dBm | 10 V | 10 V | 0 V | 0 V | 10 V | 0 V |
| -60 dBm | 10 V | 10 V | 0 V | 0 V | 10 V | 10 V |
| -70 dBm | 10 V | 10 V | 0 V | 10 V | 0 V | 10 V |
| -80 dBm | 10 V | 10 V | 0 V | 10 V | 10 V | 0 V |
| -90 dBm | 10 V | 10 V | 0 V | 10 V | 10 V | 10 V |
| -100 dBm | 10 V | 10 V | 10 V | 10 V | 0 V | 10 V |
| -110 dBm | 10 V | 10 V | 10 V | 10 V | 10 V | 0 V |
| -120 dBm | 10 V | 10 V | 10 V | 10 V | 10 V | 10 V |

Where the above table shows a voltage of 10 V this is taken as being the nominal unregulated voltage that appears on pin 1. Where 0 V is shown there will be a small positive voltage, not exceeding 0.4 V, due to the saturation voltage of the driver IC2 on AD2.

## INSTRUMENT CALIBRATION

### EAROM initialization

125. If the EAROM store on AA2 Microprocessor board has been replaced or erased, it is first necessary to set the EAROM to sensible stored values. After unlocking the second functions use Second Function 9 to enter and store 0 if the instrument is a 2018 and a 1 if the instrument is a 2019. Then enter the required r.f. level units into Second Function 5 and set the GPIB address (if fitted). Then enter valid instrument settings into the instrument stores labelled 10 to 19. If it is required to check that the f.m. system is functioning, enter valid f.m. tracking numbers into the f.m. tracking points at the carrier frequency of interest. On completion select Second Function '.' (decimal point) to re-calculate and store the amended EAROM check sum data.

### Internal frequency standard

126. Using a frequency counter operated from a high accuracy frequency standard monitor the frequency standard output from the rear panel socket. The frequency standard may be adjusted without removing the external covers of the instrument by adjusting R1 on AA/B0. Access to R1 is gained using a small screwdriver inserted through the group of vents on the right-hand side of the instrument at the top front corner. R1 is located in line with the vent that is second from the rear of that group of vents.

RF level

127. Calibration of the output r.f. level requires the access to second function operations. An accurate power meter is required to set up the r.f. level calibration. The 10 dB step attenuator contributes significantly to level errors for outputs below -3.0 dBm. Specialized equipment is required to set up the attenuator and is not covered in detail in this procedure. The following procedure is used to set up the r.f. level at levels greater than -3.1 dBm. If the recalibration is required only on a routine basis (i.e. their has been no major fault in the level control system) steps (2) and (3) may be omitted if the difference in r.f. level between 7 dBm and -2.9 dBm is 9.9 dB ±0.15 dB.

(1) Enter SECOND FUNCT "0" and overcome the second degree protection by carrying out the Second level operation unlocking procedure. Details of this procedure are given in Chap. 4, page 38.

(2) Set the carrier to 10 MHz and enter SECOND FUNCT "7". Enter the number 050 on the keypad followed by the STORE key. Repeat this procedure at 520 MHz and 1040 MHz (only if it is a 2019) and entering the numbers 100 and 170 respectively.

(3) Set the carrier to 10 MHz and the level to 7 dBm. Adjust R86 on AC4 for an output of 7 dBm measured on a power meter at the r.f. output connector. Set the output level to -2.9 dBm. Adjust R89 on AC4 to obtain the correct output level. Repeat steps 2 and 3 until levels are correct to within 0.1 dB.

(4) The output level can now be accurately set up from the front panel alone by adjusting the calibration at 3 carrier frequencies using the second function operation. Set the carrier to 10 MHz and the level to 7 dBm. Enter SECOND FUNCT "7". The output level may be adjusted by entering a 3 digit number between 000 and 255 followed by the STORE key.

Note...

Do not exceed the number entered at 520 MHz - in this case 100.

Increasing the number entered will increase the output level. When a satisfactory entry is obtained this procedure is repeated at a carrier frequency of 520 MHz. In this case the number entered should not be less than that stored at 10 MHz and should not be more than that stored at 1040 MHz. After completing the entry at 520 MHz repeat the same procedure at 1040 MHz if the instrument is a 2019. The number entered should not be less than that entered at 520 MHz.

(5) Check the r.f. level accuracy at 7 dBm and -2.9 dBm is better than ±0.4 dB from 10 MHz to 520 MHz, and better than 0.8 dB from 520 MHz to 1040 MHz. On 2019, if necessary, the calibration number at 1040 MHz can be adjusted to give the best average accuracy from 520 MHz to 1040 MHz.

(6) On completion of step (5) select SECOND FUNCT '•' to recalculate and store the amended EAROM check sum data.

(7) Relock the second function by entering SECOND FUNCT "0".

(8) After calibrating the r.f. level it is advisable to check the a.m. calibration.

AM calibration

128. An accurate modulation meter and a distortion meter are required to calibrate the a.m.

(1) Set R23 on AC5 (PRE-MOD) fully clockwise.

(2) Set the instrument to give 0 dBm at 100 MHz with the a.m. set to internal modulation at 1 kHz rate and 80% depth. Adjust R30 on AD3 to give 80% modulation depth as measured by the modulation meter.

(3) Adjust R23 on AC5 to give minimum a.m. distortion. Recheck step (2).

(4) Set the carrier frequency to 400 MHz and check that the a.m. distortion and level accuracy is within specification.

(5) Monitor pin 14 of IC3 on AC4 with a d.c. coupled oscilloscope. Set the modulation depth to 99%. Switch the a.m. off temporarily and note the d.c. voltage level observed on the oscilloscope. Switch the a.m. back on and adjust R77 on AC4 such that the negative tips of the sine wave on pin 14 of IC3 come to a voltage, with respect to ground, of 1% of that noted previously.

(6) Set the instrument to give 80% depth at 300 Hz rate internal modulation. Adjust R95 on AC4 to give the minimum ripple at the modulation frequency on IC1, pin 1 on AC4 (TP2).

FM calibration

129. An accurate modulation meter is required to calibrate the f.m. Calibration adjustments can take one of two forms. If the f.m. is out of calibration at all carrier frequencies and deviations by a consistent percentage the calibration can be adjusted using R33 on AD3. If, however, recalibration is necessary because of work carried out which may result in less predictable changes (e.g. to AB3) the f.m. should be recalibrated as follows under second function control. This recalibration can be easily accomplished using the GPIB if the modulation meter and 2018/2019 have a GPIB fitted and a controller with a suitable program is available.

(1) Set the instrument to 520 MHz at 0 dBm. Set the f.m. to 100 kHz deviation at 1 kHz rate in the internal mode. Set the carrier frequency increment size to 4.15 MHz. Enter SECOND FUNCT "0" and overcome the second degree protection by carrying out the Second level operation unlocking procedure. Details of this procedure are given in Chap. 4, page 38.

(2) Enter SECOND FUNCT "8". The r.f. level display will show a number corresponding to the tracking data at 520 MHz. This number is changed in order to obtain 100 kHz deviation as measured by the modulation meter. The number can be changed by entering a new 3 digit number or by using the increment keys. When the best value is found pressing the STORE key will store the data in the non-volatile memory. If the store key is not pressed the number will return to its previous setting when you exit from the second function mode.

(3) Enter CARRIER FREQ and increment down in frequency by pressing the increment key. Then repeat the procedure given in section 2 at the new carrier frequency. Keep repeating this procedure until a carrier frequency of 437 MHz is reached. Then reset the carrier to 437.00001 MHz and repeat the procedure for entering new tracking data. This will complete the tracking of oscillator 4 on AB3.

(4) The above procedure has to be repeated for the other 3 oscillators on AB3. Oscillator 3 is tracked by setting an incremental carrier of 3.45 MHz and starting at a carrier of 437 MHz. On reaching 368 MHz the carrier is reset to 368.00001 MHz and the last tracking point for oscillator 3 can be entered. Oscillator 2 is tracked by setting an incremental carrier of 2.95 MHz and starting at a carrier of 368 MHz. On reaching 309 MHz the carrier is set to 309.00001 MHz and the last tracking point for oscillator 2 can be entered. Oscillator 1 is tracked by setting an incremental carrier of 2.45 MHz and starting at a carrier of 309 MHz. On reaching 260 MHz the carrier is reset to 260.00001 MHz and the last tracking point for oscillator 1 can be entered.

(5) On completion select SECOND FUNCT '.' (decimal point) to recalculate and store the amended EAROM check sum data.

(6) Relock the second function by entering SECOND FUNCT "0".

External modulation

130. There is no need to calibrate the external modulation when the modulation a.l.c. is on. An accurate a.c. voltmeter and a modulation meter is required to calibrate the external modulation when the a.l.c. is off.

(1) Set the instrument to external modulation at any convenient modulation setting (a.m. or f.m.).

(2) Apply an external modulation source of 1 kHz frequency and adjust its level to give 1 V r.m.s. as measured by the voltmeter.

(3) Set the modulation a.l.c. on and note the reading on the modulation meter. Switch the a.l.c. off and adjust R16 on AD3 to give the same reading on the modulation meter.

Chapter 5, Annex A

# MEASUREMENT OF PHASE NOISE IN SIGNAL GENERATORS

## CONTENTS

Page
1 Side band noise
Reprint of article : 'Measurement of phase noise in signal generators'

Fig.
1 A typical phase noise plot for the TF 2020
2 Basic quadrature technique
3 Quadrature technique incorporating a p.l.l. to obtain phase quadrature at the mixer
4 Quadrature technique with a low noise pre-amplifier
5 FM discriminator method
6 An amplifier configuration
7 Residual phase noise characteristics

## Side band noise

1. Side band noise measurements require the use of specialized equipment which is not always available to the user. Some methods of measuring side band noise are contained in this annex.

# Chapter 6

## REPLACEABLE PARTS

## CONTENTS

Para.
1 Introduction
3 Abbreviations
4 Component values
6 Ordering
7 Electrical components
7 Unit AA0 - RF BOX 1 AA/B0
8 Unit AA1 - L.S.D. LOOP
9 Unit AA2 - MICROPROCESSOR SYSTEM
10 Unit AA3 - FREQUENCY STANDARD
11 Unit AB1 - OUTPUT LOOP V.R.D.
12 Unit AB2 - DIVIDE-BY-TWO CHAIN AND FM DRIVE
13 Unit AB3 - OSCILLATORS BOARD
14 Unit AB4 - O/P PHASE DETECTOR
15 Unit AB5 - VCXO LOOP
16 Unit AC0 - RF BOX 2 (44990-352S)
17 Unit AC2 - B.F.O. SYSTEM
18 Unit AC3 - FILTER BOARD (2018 only)
19 Unit AC4 - OUTPUT AMPLIFIER
20 Unit AC5 - AMPLITUDE MODULATOR
21 Unit AC13 - FILTER & FREQ DOUBLER BOARD (2019 only)
22 Unit AD1 - DISPLAY BOARD
23 Unit AD2 - MOTHER BOARD
24 Unit AD3 - MOD. OSC. AND FM CONTROL BOARD
25 Unit AD4 - KEYBOARD
26 Unit AE1 - POWER SUPPLY BOARD
27 Unit AM0 - BASIC MODULE (44990-380J)
28 Unit AT0 - 10DB STEP ATTENUATOR ASSEMBLY
29 Unit AT1 - ATTENUATOR BOARD
30 Unit AT2 - ATTENUATOR CONTROL
31 Mechanical components

Fig. Page
1 Miscellaneous mechanical components 71/72

## INTRODUCTION

1. Each sub-assembly or printed circuit board in this equipment has been allocated a reference designator code, e.g. A0, A1, A2 etc.

2. The complete component reference includes its reference designator as a prefix e.g. A2C1 (capacitor C1 on sub-assembly A2) but for convenience in the text and diagrams the prefix is omitted unless it is needed to avoid confusion. However when ordering replacements or in correspondence the complete component reference must be quoted.

ABBREVIATIONS

3. Electrical components are listed in alpha-numerical order of their complete circuit reference and the following standard abbreviations are used:

| | |
|---|---|
| ADC | analogue-digital converter |
| CAP | capacitor |
| CARR | carrier |
| CARB | carbon |
| CC | carbon composition |
| CDE CNV | code converter |
| CER | ceramic |
| CERM | cermet |
| CF | carbon film |
| COAX | coaxial |
| CON | connector |
| CTR | counter |
| DAC | digital-analogue converter |
| DEC/DMX | decoder/demultiplexer |
| DECOD | decoder |
| DIL | dual in-line |
| DIV | divider |
| DRIV | driver |
| ELEC | electrolytic |
| ENCOD | encoder |
| FEM | female |
| FF | flip-flop (bistable) |
| FILTERCON | filtering capacitor |
| GER | germanium |
| GP | general purpose |
| ICA | integrated circuit, analogue |
| ICD | integrated circuit, digital |
| IND | inductor |
| INV | inverter |
| LD/T | lead through |
| MF | metal film |
| MG | metal glaze |
| MISC | miscellaneous |
| MO | metal oxide |
| MP | microprocessor |
| MP SUPP | microprocessor support |
| MUX | multiplexer |
| NET | network |
| PC | polycarbonate |
| PETP | (polyester)polyethelene terephthalate |
| PS | polystyrene |
| PLL | phase-locked loop |

| | |
|---|---|
| Q/ACT | quick acting |
| RECT | rectifier |
| RES | resistor |
| RV | resistor, variable |
| RX | receiver |
| SAPPH | sapphire |
| SEC | secondary |
| SH REG | shift register |
| SIL | silicon |
| SW | switch |
| T/LAG | time lag |
| TANT | tantalum |
| TOG | toggle |
| TRANS | transistor |
| TX | transmitter |
| VAR | variable |
| VREG | voltage regulator |
| WW | wirewound |
| ! | static sensitive component |
| % + | asymmetric tolerance |

COMPONENT VALUES

4. One or more of the components fitted in the equipment may differ from those listed in this chapter for any of the following reasons:

(a) Components indicated by a * have their values selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the equipment is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

5. When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the equipment.

ORDERING

6. When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required:-

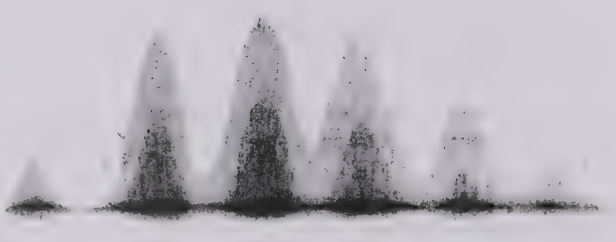
(1) Type# and serial number of equipment.

(2) Complete circuit reference.

(3) Description.

(4) Part number.

#As given on the serial number label at the rear of the equipment; if this is superseded by a model number label, quote the model number instead of the type number.



| Fig. 1 Item | Description | Part no |
|---|---|---|
| 11 | Selector plate | 35902-441Z |
| 12 | Rear trim | 34900-470E |
| 13 | Rear panel assy. | 35903-229F |
| 14 | End cap | 37590-255C |
| | End cap | 37590-256R |
| 15 | Liner | 22315-584T |
| 16 | Cover moulding | 37590-257B |
| 17 | Steel liner | 22315-587M |
| 18 | Right-hand side trim infill | 35902-386W |
| 19 | Side rail assy. | 34900-723V |
| 20 | Right-hand side frame assy. | 35903-315C |
| 21 | PVC extrusion | 22315-590M |
| 22 | Bush | 35900-785V |
| 23 | Rear lower foot | 37590-224R |
| | Stud | 37590-223C |
| 24 | Side trim infill (handle) | 35902-368Z |
| 25 | Screw | 21857-465C |
| 26 | Screw cup washer | 21171-550W |
| 27 | Front foot | 37590-253X |
| | Tilt stand | 37590-254M |

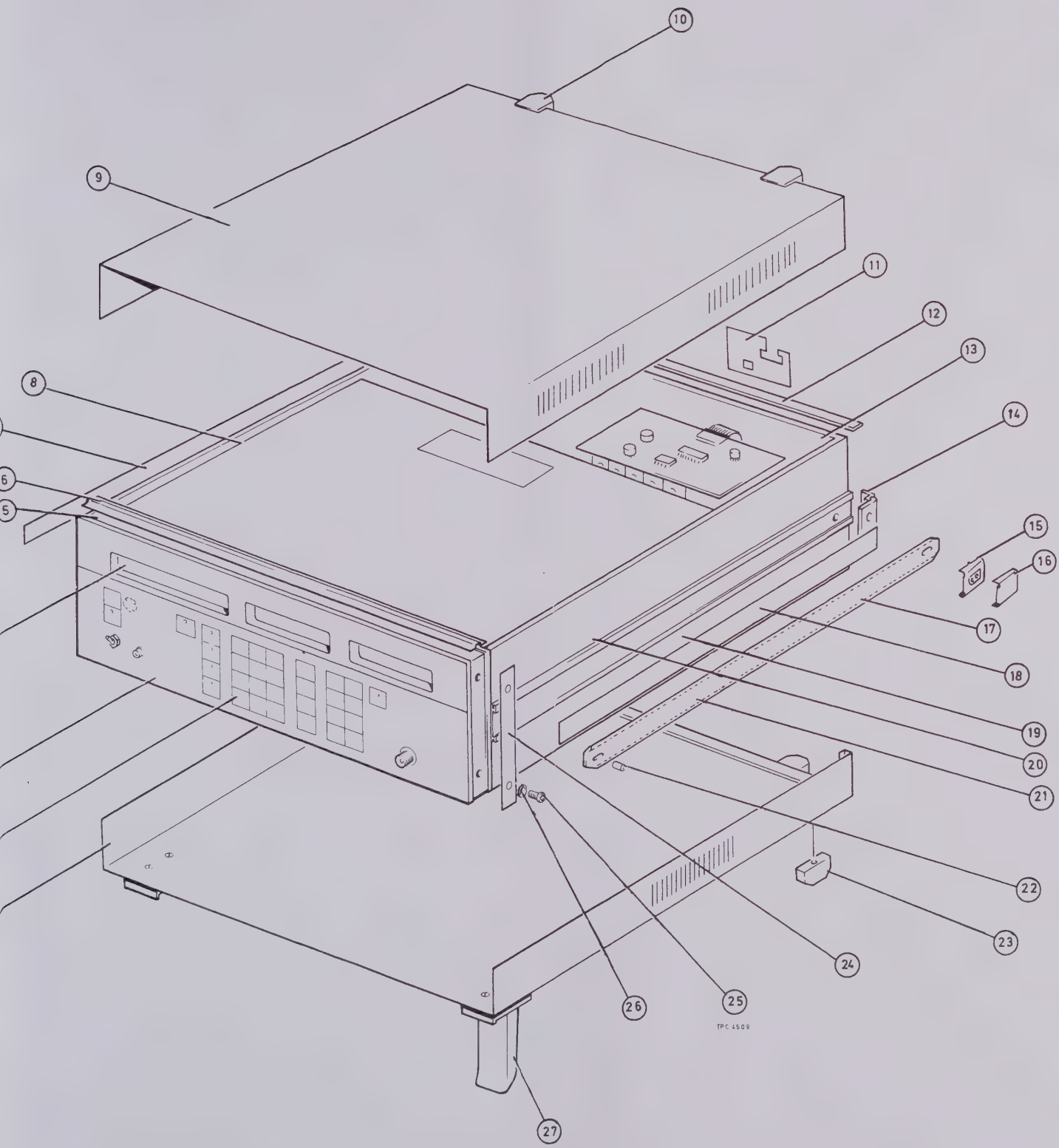



*Fig. 1 Miscellaneous mechanical parts*

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA0 | - RF BOX 1 AA/B0(44990-351V) | Issue 9 |
| 7. When ordering, prefix circuit reference with AA0 | | |
| C1 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C2 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C3 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C4 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C5 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C6 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C7 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C8 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C9 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C10 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C11 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C12 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C13 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C14 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C15 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C16 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C17 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C18 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C19 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C20 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C21 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C22 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C23 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C24 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C25 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C26 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C27 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C28 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C29 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C30 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C31 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C32 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C33 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C34 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C35 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C36 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C37 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C38 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C39 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C40 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA0 | - RF BOX 1 AA/B0 | (Contd.) |
| C41 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C42 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C43 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C44 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C45 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C46 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C47 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C48 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C49 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C50 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C51 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C52 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C53 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C54 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C55 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C56 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C57 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C58 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C59 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C60 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C61 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C62 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C63 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C64 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C65 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C66 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C67 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C68 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C69 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C70 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C71 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C72 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C73 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C74 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C75 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C76 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C77 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C78 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C79 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C80 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C81 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C82 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C83 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA0 | - RF BOX 1 AA/B0 | (Contd.) |
| C84 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C85 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C86 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C87 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C88 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C89 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C90 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C91 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C92 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C93 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C94 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C95 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C96 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C97 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C98 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C99 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C100 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C101 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C102 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C103 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C104 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C105 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C106 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C107 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C108 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C109 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C111 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C112 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C113 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C114 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C115 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C116 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C117 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C118 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C119 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C120 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C121 | CAP ELEC 47UF 10V 20%+ | 26415-809E |
| D1 | DIODE ZENER 1N825/A 6.2V 5% | 28371-494Z |
| IC1 | UA7805 | 28461-707G |
| L1 | IND CHOKE 100UH 10% | 23642-561W |
| L2 | IND CHOKE 100UH 10% | 23642-561W |
| L3 | IND CHOKE 100UH 10% | 23642-561W |
| L4 | IND CHOKE 100UH 10% | 23642-561W |
| L5 | IND CHOKE 100UH 10% | 23642-561W |
| L6 | IND CHOKE 100UH 10% | 23642-561W |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA0 | - RF BOX 1 AA/B0 | (Contd.) |
| L7 | IND CHOKE 100UH 10% | 23642-561W |
| L8 | IND CHOKE 100UH 10% | 23642-561W |
| L9 | IND CHOKE 100UH 10% | 23642-561W |
| L10 | IND CHOKE 100UH 10% | 23642-561W |
| L11 | IND CHOKE 100UH 10% | 23642-561W |
| L12 | IND CHOKE 100UH 10% | 23642-561W |
| L13 | IND CHOKE 100UH 10% | 23642-561W |
| L14 | IND CHOKE 100UH 10% | 23642-561W |
| L15 | IND CHOKE 100UH 10% | 23642-561W |
| L16 | IND CHOKE 100UH 10% | 23642-561W |
| L17 | IND CHOKE 100UH 10% | 23642-561W |
| L18 | IND CHOKE 100UH 10% | 23642-561W |
| L19 | IND CHOKE 100UH 10% | 23642-561W |
| L20 | IND CHOKE 100UH 10% | 23642-561W |
| L21 | IND CHOKE 100UH 10% | 23642-561W |
| L22 | IND CHOKE 100UH 10% | 23642-561W |
| L23 | IND CHOKE 100UH 10% | 23642-561W |
| L24 | IND CHOKE 100UH 10% | 23642-561W |
| L25 | IND CHOKE 100UH 10% | 23642-561W |
| L26 | IND CHOKE 100UH 10% | 23642-561W |
| L27 | IND CHOKE 100UH 10% | 23642-561W |
| L28 | IND CHOKE 100UH 10% | 23642-561W |
| L29 | IND CHOKE 100UH 10% | 23642-561W |
| L30 | IND CHOKE 100UH 10% | 23642-561W |
| L31 | IND CHOKE 100UH 10% | 23642-561W |
| L32 | IND CHOKE 100UH 10% | 23642-561W |
| L33 | IND CHOKE 100UH 10% | 23642-561W |
| L34 | IND CHOKE 100UH 10% | 23642-561W |
| L45 | IND CHOKE 100UH 10% | 23642-561W |
| L46 | IND CHOKE 100UH 10% | 23642-561W |
| PLBW | CONN ASSY PLBW-PLDH | 43129-692K |
| PLBX | CONN ASSY PLBX-SKAV | 43129-664B |
| R1 | RV CERM 1K0 LIN 1W PANEL MTG | 25748-499T |
| R2 | RES MF 620R 1/4W 2% | 24773-268B |
| SKAR | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| SKAU | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| SKBC | CONN ASSY SKBC | 43129-669E |
| SKBD | CONN ASSY | 43129-671H |
| SKBE | CONN ASSY SKBE-SKBL | 43129-670Z |
| SKBF | CONN ASSY | 43129-671H |
| SKBH | CONN ASSY | 43129-671H |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA0 | - RF BOX 1 AA/B0 | (Contd.) |
| SKBJ | CONN ASSY | 43129-671H |
| SKBK | CONN ASSY SKBK | 43129-659C |
| SKBM | CONN ASSY SKBM-SKBP | 43129-660X |
| SKBN | CONN ASSY SKBN | 43129-661M |
| SKBR | CONN ASSY | 43129-678F |
| SKBS | CONN ASSY | 43129-671H |
| SKBT | CONN ASSY SKBT-PLDL | 43129-663R |
| SKBU | CONN ASSY SKBU-SKCB | 43129-662C |
| SKBV | CONN ASSY | 43129-671H |
| SKBY | CONN ASSY | 43129-678F |
| SKBZ | CONN ASSY | 43129-671H |
| SKCC | CONN ASSY SKCC-SKCF | 43129-665K |
| SKCD | CONN ASSY | 43129-693M |
| SKCE | CONN ASSY SKCE | 43129-666A |
| SKCJ | CONN ASSY | 43129-693M |
| SKCK | CONN ASSY SKCK-PLDJ | 43129-667Z |
| SKDH | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| SKDJ | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| SKDL | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| X6 | 10MHZ CRYSTAL OSCILLATOR | 44990-337E |
| X11 | FERRITE BEAD | 41372-006T |
| X12 | FERRITE BEAD | 41372-006T |
| X13 | FERRITE BEAD | 41372-006T |
| X14 | FERRITE BEAD | 41372-006T |
| X15 | FERRITE BEAD | 41372-006T |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA1 | - L.S.D. LOOP | Issue 1 |
| 8. When ordering, prefix circuit reference with AA1 | | |
| | Complete unit | 44828-426W |
| C1 | CAP PETP 0.1UF 100V 10% | 26582-211B |
| C2 | CAP PETP 1.0UF 100V 10% | 26582-217U |
| C3 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C4 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C5 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C6 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C7 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C17 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C18 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C19 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C20 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C21 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C22 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C23 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C24 | CAP CER .0015UF 63V 10% PLATE | 26383-593A |
| C25 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C26 | CAP CER 0.01UF 100V 20% DISC | 26383-582T |
| C27 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C28 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| D1 | DIODE VAR CAP MVAM125 1V 500PF | 28381-340V |
| D2 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D3 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D4 | DIODE HOT CARR 1N5390 | 28349-005Z |
| IC1 | ICD FF D 74LS74 DUAL +EDG TR | 28462-611A |
| IC2 | ICD NAND 74LS10 TRIP 3INP | 28466-351Y |
| IC3 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC4 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC5 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA1 | - L.S.D. LOOP | (Contd.) |
| IC6 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC7 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC8 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC9 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC10 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC11 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC12 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC13 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC14 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC15 | ICD CTR 74LS160 4BIT BIN PRE | 28464-123P |
| IC16 | ICD NAND 74S133 13INP | 28466-357V |
| IC17 | ICD NAND 74S133 13INP | 28466-357V |
| L1 | IND CHOKE .47UH 10% | 23642-547Y |
| L2 | IND CHOKE .47UH 10% | 23642-547Y |
| PLBL | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBM | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBN | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES MF 6K8 1/4W 2% | 24773-293D |
| R2 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R3 | RES MF 3K3 1/4W 2% | 24773-285F |
| R4 | RES MF 1K0 1/4W 2% | 24773-273A |
| R5 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R6 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R7 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R8 | RES MF 1K0 1/4W 2% | 24773-273A |
| R9 | RES MF 1K0 1/4W 2% | 24773-273A |
| R10 | RES MF 1K0 1/4W 2% | 24773-273A |
| R11 | RES MF 1K0 1/4W 2% | 24773-273A |
| TR1 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR2 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR3 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA2 | - MICROPROCESSOR SYSTEM | Issue 4 |
| 9. When ordering, prefix circuit reference with AA2 | | |
| | Complete unit | 44828-427D |
| C1 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C2 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C3 | CAP ELEC 100UF 25V 20%+ P/CCT | 26423-243M |
| C4 | CAP ELEC 100UF 25V 20%+ P/CCT | 26423-243M |
| C5 | CAP ELEC 100UF 25V 20%+ P/CCT | 26423-243M |
| C6 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C16 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C17 | CAP PETP 0.1UF 100V 10% | 26582-211B |
| C18 | CAP PETP 0.1UF 100V 10% | 26582-211B |
| C20 | CAP ELEC 100UF 25V 20%+ P/CCT | 26423-243M |
| C21 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C22 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C23 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C24 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C25 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C26 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C27 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C28 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C32 | CAP ELEC 100UF 25V 20%+ P/CCT | 26423-243M |
| D1 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D2 | DIODE ZENER BZY88C3V0 3V 5% | 28371-203G |
| D3 | DIODE ZENER BZY88C3V0 3V 5% | 28371-203G |
| D4 | DIODE ZENER BZY88C15 15V 5% | 28372-303M |
| D5 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D6 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D7 | DIODE ZENER BZY88C15 15V 5% | 28372-303M |
| D8 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D9 | DIODE SIL 1N4148 100V JUNC | 28336-676J |

| Circuit Ref | Description | | Part Number |
|---|---|---|---|
| Unit AA2 | - MICROPROCESSOR SYSTEM | | (Contd.) |
| IC1 | ICD MP P8085A 8BIT NMOS | ! | 28469-396K |
| IC2 | ICD NAND 74LS00 QUAD 2INP | | 28466-345H |
| IC3 | ICD MP SUP 8155 2KRAM+I/O+TIM | ! | 28469-304E |
| IC4 | ICD BUFF 74LS245 OCT TXRX | | 28469-188B |
| IC5 | ICD BUFF 74LS244 OCT 3ST | | 28469-182T |
| IC6 | ICD DEC/DMX 74LS138 3-8 | | 28465-027F |
| IC7 | ICD MP SUP 8155 2KRAM+I/O+TIM | ! | 28469-304E |
| IC8 | ICD PROM ER3400 1KX4BIT EA | ! | 28471-010H |
| IC9 | ICD BUFF 4049 HEX I | ! | 28469-162Z |
| IC10 | ICD FF D 74LS273 OCT +EDG TR | | 28462-615U |
| IC11 | ICD LATCH 74LS373 OCT 3ST | | 28462-410E |
| IC12 | ICD DEC/DMX 74LS138 3-8 | | 28465-027F |
| IC13 | ICD B2732 EPROM A | | |
| IC14 | ICD B2732 EPROM B Set of four | ! | 44533-027B |
| IC15 | ICD B2732 EPROM C | | |
| IC16 | ICD B2732 EPROM D | | |
| PLBC | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBD | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBE | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBF | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBH | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBJ | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLBK | CON PART PCB POST SQUARE PIN | | 23435-188V |
| R1 | RES MF 47K 1/4W 2% | | 24773-313H |
| R2 | RES MF 10K 1/4W 2% | | 24773-297M |
| R3 | RES MF 10K 1/4W 2% | | 24773-297M |
| R4 | RES MF 10K 1/4W 2% | | 24773-297M |
| R5 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R6 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R7 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R8 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R9 | RES MF 10K 1/4W 2% | | 24773-297M |
| R10 | RES MF 10K 1/4W 2% | | 24773-297M |
| R11 | RES MF 15K 1/4W 2% | | 24773-301P |
| R12 | RES MF 4K7 1/4W 2% | | 24773-289W |
| R13 | RES MF 15K 1/4W 2% | | 24773-301P |
| R14 | RES MF 330R 1/4W 2% | | 24773-261D |
| R15 | RES MF 10K 1/4W 2% | | 24773-297M |
| R16 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R17 | RES MF 10K 1/4W 2% | | 24773-297M |
| R18 | RES MF 4K7 1/4W 2% | | 24773-289W |
| R19 | RES MF 4K7 1/4W 2% | | 24773-289W |
| R20 | RES MF 10K 1/4W 2% | | 24773-297M |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA2 | - MICROPROCESSOR SYSTEM | (Contd.) |
| R21 | RES MF 10K 1/4W 2% | 24773-297M |
| R22 | RES MF 10K 1/4W 2% | 24773-297M |
| R23 | RES MF 15K 1/4W 2% | 24773-301P |
| R24 | RES MF 1K0 1/4W 2% | 24773-273A |
| R25 | RES MF 47K 1/4W 2% | 24773-313H |
| TR1 | TRANS PNP SIL BC307A 45V | 28435-227H |
| TR2 | TRANS PNP SIL BC307A 45V | 28435-227H |
| TR3 | TRANS NPN SIL ZTX107AL 45V | 28455-421X |
| TR4 | TRANS NPN SIL ZTX107AL 45V | 28455-421X |
| TR5 | TRANS NPN SIL ZTX107AL 45V | 28455-421X |
| TR6 | TRANS PNP SIL BC307A 45V | 28435-227H |
| TR7 | TRANS NPN SIL ZTX107AL 45V | 28455-421X |
| TR8 | TRANS PNP SIL BC307A 45V | 28435-227H |
| TR9 | TRANS PNP SIL BC307A 45V | 28435-227H |
| XL1 | CRYSTAL 6.144MHZ FLY LDS | 28312-054J |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AA3 | - FREQUENCY STANDARD | Issue 4 |
| 10. When ordering, prefix circuit reference with AA3 | | |
| | Complete unit | 44828-428T |
| C1 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C3 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C4 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C5 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C6 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP PS 220PF 350V 2% | 26516-329B |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| D1 | DIODE SIL BA482 35V JUNC | 28335-675R |
| IC1 | ICD NAND 74LS00 QUAD 2INP | 28466-345H |
| IC2 | ICD NOR 74128 QUAD 2INP BUF | 28466-224S |
| IC3 | ICD CTR 74LS390 DUAL 4BIT DEC | 28464-127R |
| IC4 | ICD CTR 74LS390 DUAL 4BIT DEC | 28464-127R |
| L1 | IND CHOKE 1.0UH 10% | 23642-549L |
| PLBP | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBR | CON PART PCB POST SQUARE PIN | 23435-188V |
| R2 | RES MF 10K 1/4W 2% | 24773-297M |
| R3 | RES MF 10K 1/4W 2% | 24773-297M |
| R4 | RES MF 4K7 1/4W 2% | 24773-289W |
| R5 | RES MF 10K 1/4W 2% | 24773-297M |
| R6 | RES MF 100R 1/4W 2% | 24773-249J |
| R7 | RES MF 180R 1/4W 2% | 24773-255V |
| R8 | RES MF 1K0 1/4W 2% | 24773-273A |
| R9 | RES MF 180R 1/4W 2% | 24773-255V |
| R10 | RES MF 1K0 1/4W 2% | 24773-273A |
| R11 | RES MF 180R 1/4W 2% | 24773-255V |
| TR1 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR2 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR3 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB1 | - OUTPUT LOOP V.R.D. | Issue 3 |
| 11. When ordering, prefix circuit reference with AB1 | | |
| | Complete unit | 44828-429P |
| C1 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C3 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C4 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C5 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C6 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C17 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C18 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C19 | CAP TANT 22UF 16V 20% BEAD | 26486-230B |
| D1 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D4 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| IC1 | ICD DIV SP8607B ECL /2 PRESC | 28462-023B |
| IC2 | ICD DIV SP8647B/10,11 TTL O/P | 28464-015W |
| IC3 | ICD NAND 74S00N QUAD 2INP | 28466-331D |
| IC4 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC5 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC6 | ICD CTR 74LS196 4BIT DEC PRE | 28464-016D |
| IC7 | ICD CTR 74196 4BIT DEC PR | 28464-004Y |
| IC8 | ICD CTR 74LS196 4BIT DEC PRE | 28464-016D |
| IC9 | ICD CTR 74LS196 4BIT DEC PRE | 28464-016D |
| IC10 | ICD FF D 74S74 DUAL +EDG TR | 28462-607K |
| IC11 | ICD FF JK 74S112 DUAL -EDG TR | 28462-015P |
| IC12 | ICD NAND 74S133 13INP | 28466-357V |
| PLBS | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBT | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBU | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES CC 51R 1/8W 5% | 24331-989P |
| R2 | RES MF 10K 1/4W 2% | 24773-297M |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB1 | - OUTPUT LOOP V.R.D. | (Contd.) |
| R3 | RES MF 1K8 1/4W 2% | 24773-279N |
| R4 | RES CC 22R 1/8W 5% | 24331-988T |
| R5 | RES CC 100R 1/8W 5% | 24331-997B |
| R6 | RES MF 10K 1/4W 2% | 24773-297M |
| R7 | RES MF 2K7 1/4W 2% | 24773-283L |
| R8 | RES MF 3K3 1/4W 2% | 24773-285F |
| R9 | RES MF 56R 1/4W 2% | 24773-243H |
| R10 | RES MF 470R 1/4W 2% | 24773-265M |
| R11 | RES MF 1K5 1/4W 2% | 24773-277U |
| R12 | RES MF 680R 1/4W 2% | 24773-269K |
| R13 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R14 | RES MF 2K2 1/4W 2% | 24773-281Y |
| TR1 | TRANS NPN SIL BFR90 15V | 28452-167U |
| Unit AB2 | - DIVIDE-BY-TWO CHAIN AND FM DRIVE | Issue 1 |
| 12. When ordering, prefix circuit reference with AB2 | | |
| | Complete unit | 44828-430D |
| C1 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C2 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C3 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C4 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C5 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C6 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C9 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C10 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C14 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C17 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C18 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C19 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C20 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB2 | - DIVIDE-BY-TWO CHAIN AND FM DRIVE (Contd.) | |
| C21 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C22 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C23 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C24 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C25 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C26 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C27 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C28 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C29 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C30 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C31 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C32 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| D1 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D2 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D3 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D4 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D5 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D6 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D7 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D8 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| IC1 | ICD DIV SP8607B ECL /2 PRESC | 28462-023B |
| IC2 | ICD DIV SP8604B ECL /2 PRESC | 28462-022R |
| IC3 | ICD FF D 10231 M/SLAVE | 28462-610K |
| IC4 | ICD FF JK 74S112 DUAL -EDG TR | 28462-015P |
| IC5 | ICD FF JK 74LS112 DUAL -EDG TR | 28462-020M |
| IC6 | ICD AND 10104 QUAD 2INP ECL | 28466-015G |
| IC7 | ICD NAND 74LS00 QUAD 2INP | 28466-345H |
| IC8 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC9 | ICD FF D 74LS175 QUAD +EDG TR | 28462-614E |
| IC10 | ICA AMP NE5534AH H-PRF TO99 | 28461-329V |
| L1 | IND CHOKE 4.7UH 10% | 23642-553J |
| L2 | IND CHOKE 4.7UH 10% | 23642-553J |
| L3 | IND CHOKE 4.7UH 10% | 23642-553J |
| PLBV | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCJ | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCK | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES CC 100R 1/8W 5% | 24331-997B |
| R2 | RES MF 1K5 1/4W 2% | 24773-277U |
| R3 | RES MF 150R 1/4W 2% | 24773-253F |
| R4 | RES MF 51R 1/4W 2% | 24773-242Z |
| R5 | RES CHIP 10R 5% | 24681-042H |
| R6 | RES MF 4K7 1/4W 2% | 24773-289W |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB2 | - DIVIDE-BY-TWO CHAIN AND FM DRIVE (Contd.) | |
| R7 | RES MF 10K 1/4W 2% | 24773-297M |
| R8 | RES MF 470R 1/4W 2% | 24773-265M |
| R9 | RES MF 4K7 1/4W 2% | 24773-289W |
| R10 | RES MF 51R 1/4W 2% | 24773-242Z |
| R11 | RES MF 470R 1/4W 2% | 24773-265M |
| R12 | RES MF 4K7 1/4W 2% | 24773-289W |
| R13 | RES CC 51R 1/8W 5% | 24331-989P |
| R14 | RES CC 100R 1/8W 5% | 24331-997B |
| R15 | RES MF 10K 1/4W 2% | 24773-297M |
| R16 | RES MF 2K7 1/4W 2% | 24773-283L |
| R17 | RES MF 10K 1/4W 2% | 24773-297M |
| R18 | RES MF 1K2 1/4W 2% | 24773-275H |
| R19 | RES MF 4K7 1/4W 2% | 24773-289W |
| R20 | RES MF 51R 1/4W 2% | 24773-242Z |
| R21 | RES MF 220R 1/4W 2% | 24773-257W |
| R22 | RES MF 51R 1/4W 2% | 24773-242Z |
| R23 | RES CC 51R 1/8W 5% | 24331-989P |
| R24 | RES CC 270R 1/8W 5% | 24331-992P |
| R25 | RES MF 1K0 1/4W 2% | 24773-273A |
| R26 | RES MF 1K0 1/4W 2% | 24773-273A |
| R27 | RES MF 470R 1/4W 2% | 24773-265M |
| R28 | RES MF 4K7 1/4W 2% | 24773-289W |
| R29 | RES MF 51R 1/4W 2% | 24773-242Z |
| R30 | RES MF 10K 1/4W 2% | 24773-297M |
| R31 | RES MF 4K7 1/4W 2% | 24773-289W |
| R32 | RES MF 10K 1/4W 2% | 24773-297M |
| R33 | RES MF 10K 1/4W 2% | 24773-297M |
| R34 | RES MF 51R 1/4W 2% | 24773-242Z |
| R35 | RES MF 10K 1/4W 2% | 24773-297M |
| R36 | RES MF 680R 1/4W 2% | 24773-269K |
| R37 | RES MF 1K5 1/4W 2% | 24773-277U |
| R38 | RES MF 1K5 1/4W 2% | 24773-277U |
| R39 | RES MF 1K5 1/4W 2% | 24773-277U |
| R40 | RES MF 1K0 1/4W 2% | 24773-273A |
| R41 | RES MF 91R 1/4W 2% | 24773-248L |
| R42 | RES MF 1K5 1/4W 2% | 24773-277U |
| R43 | RES MF 2K7 1/4W 2% | 24773-283L |
| R44 | RES MF 3K0 1/4W 2% | 24773-284J |
| R45 | RES MF 5K6 1/4W 2% | 24773-291S |
| R46 | RES MF 330R 1/4W 2% | 24773-261D |
| R47 | RES MF 1K0 1/4W 2% | 24773-273A |
| R48 | RES MF 3K0 1/4W 2% | 24773-284J |
| R49 | RES MF 5K6 1/4W 2% | 24773-291S |
| R50 | RES MF 330R 1/4W 2% | 24773-261D |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB2 | - DIVIDE-BY-TWO CHAIN AND FM DRIVE (Contd.) | |
| R51 | RES MF 1K2 1/4W 2% | 24773-275H |
| R52 | RES MF 3K0 1/4W 2% | 24773-284J |
| R53 | RES MF 5K6 1/4W 2% | 24773-291S |
| R54 | RES MF 330R 1/4W 2% | 24773-261D |
| R55 | RES MF 51R 1/4W 2% | 24773-242Z |
| R56 | RES MF 1K0 1/4W 2% | 24773-273A |
| R57 | RES MF 900R 1/4W 0.25% | 24732-270N |
| R58 | RES MF 3K78 0.25W 0.25% | 24732-267N |
| R59 | RES MF 75R0 1/4W 0.25% | 24732-313V |
| R61 | RES MF 4K7 1/4W 2% | 24773-289W |
| R62 | RES MF 150R 1/4W 2% | 24773-253F |
| R63 | RES MF 4K7 1/4W 2% | 24773-289W |
| R64 | RES MF 150R 1/4W 2% | 24773-253F |
| R65 | RES MF 4K7 1/4W 2% | 24773-289W |
| R66 | RES MF 150R 1/4W 2% | 24773-253F |
| R67 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R68 | RES MF 2K2 1/4W 2% | 24773-281Y |
| RLA | RELAY REED 1CO 12V 890R | 23486-427A |
| RLB | RELAY REED 1CO 12V 890R | 23486-427A |
| RLC | RELAY REED 1CO 12V 890R | 23486-427A |
| SKBW | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| SKBX | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| TR1 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR2 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR3 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR4 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR5 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR6 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR7 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR8 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR9 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR10 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR11 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR12 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR13 | TRANS PNP SIL BFR99 25V | 28433-336F |
| TR14 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR15 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR16 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB3 | - OSCILLATORS BOARD | Issue 7 |
| 13. When ordering, prefix circuit reference with AB3 | | |
| | Complete unit | 44828-431T |
| C1 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C2 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C3 | CAP CER 2.7PF 63V .5PF PLATE | 26343-458B |
| C4 | CAP CER 22PF 50V 5% CHIP | 26343-781N |
| C5 | CAP CER 33PF 50V 5% CHIP | 26343-777Y |
| C6 | CAP CER 33PF 50V 5% CHIP | 26343-777Y |
| C7 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C8 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C9 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C10 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C11 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C12 | CAP CER 33PF 50V 5% CHIP | 26343-777Y |
| C13 | CAP CER 22PF 50V 5% CHIP | 26343-781N |
| C14 | CAP CER 22PF 50V 5% CHIP | 26343-781N |
| C15 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C16 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C18 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C19 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C20 | CAP CER 5.6PF 63V .5PF PLATE | 26343-462K |
| C21 | CAP CER 68PF 50V 5% CHIP | 26343-782L |
| C22 | CAP CER 47PF 50V 5% CHIP | 26343-780Y |
| C23 | CAP CER 47PF 50V 5% CHIP | 26343-780Y |
| C24 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C25 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C26 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C27 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C28 | CAP CER 33PF 50V 5% CHIP | 26343-777Y |
| C29 | CAP CER 22PF 50V 5% CHIP | 26343-781N |
| C30 | CAP CER 22PF 50V 5% CHIP | 26343-781N |
| C31 | CAP CER 3.3PF 63V .5PF PLATE | 26343-459K |
| C32 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C33 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C37 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| D1 | DIODE VAR CAP BB809 3V 29PF | 28381-132G |
| D3 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D4 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D6 | DIODE VAR CAP BB809 3V 29PF | 28381-132G |
| D7 | DIODE VAR CAP BB809 3V 29PF | 28381-132G |
| D9 | DIODE VAR CAP BB405 28V | 28381-101V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB3 | - OSCILLATORS BOARD | (Contd.) |
| D10 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D11 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D12 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D13 | DIODE VAR CAP BB809 3V 29PF | 28381-132G |
| D15 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| L1 | RF COIL 10UH 4T | 44290-805W |
| L2 | RF COIL 10UH 4T | 44290-805W |
| L3 | PRINTED COIL | |
| L4 | PRINTED COIL | |
| L5 | RF COIL 10UH 4T | 44290-805W |
| L6 | RF COIL 10UH 4T | 44290-805W |
| L7 | RF COIL 10UH 4T | 44290-805W |
| L8 | RF COIL 10UH 4T | 44290-805W |
| L9 | PRINTED COIL | |
| L10 | PRINTED COIL | |
| L11 | RF COIL 10UH 4T | 44290-805W |
| L12 | RF COIL 10UH 4T | 44290-805W |
| R1 | RES MF 50R 1/4W 0.25% | 24723-388Y |
| R2 | RES MF 5K6 1/4W 2% | 24773-291S |
| R3 | RES MF 470R 1/4W 2% | 24773-265M |
| R4 | RES CHIP 22R 5% | 24681-044U |
| R5 | RES MF 330R 1/4W 2% | 24773-261D |
| R6 | RES MF 470R 1/4W 2% | 24773-265M |
| R7 | RES MF 10K 1/4W 2% | 24773-297M |
| R8 | RES MF 10K 1/4W 2% | 24773-297M |
| R9 | RES CHIP 22R 5% | 24681-044U |
| R10 | RES MF 330R 1/4W 2% | 24773-261D |
| R11 | RES MF 470R 1/4W 2% | 24773-265M |
| R12 | RES MF 100R 1/4W 2% | 24773-249J |
| R13 | RES MF 10K 1/4W 2% | 24773-297M |
| R14 | RES MF 200R 1/4W 2% | 24773-256S |
| R15 | RES MF 470R 1/4W 2% | 24773-265M |
| R16 | RES MF 620R 1/4W 2% | 24773-268B |
| R17 | RES CC 33R 1/8W 5% | 24331-978J |
| R18 | RES MF 250R 1/4W 0.25% | 24723-389N |
| R19 | RES CHIP 22R 5% | 24681-044U |
| R20 | RES MF 330R 1/4W 2% | 24773-261D |
| R21 | RES MF 390R 1/4W 2% | 24773-263P |
| R22 | RES MF 10K 1/4W 2% | 24773-297M |
| R23 | RES MF 10K 1/4W 2% | 24773-297M |
| R24 | RES CHIP 22R 5% | 24681-044U |
| R25 | RES MF 330R 1/4W 2% | 24773-261D |
| R26 | RES MF 270R 1/4W 2% | 24773-259T |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB3 | - OSCILLATORS BOARD | (Contd.) |
| R27 | RES MF 820R 1/4W 2% | 24773-271B |
| R28 | RES CC 51R 1/8W 5% | 24331-989P |
| R29 | RES CHIP 10R 5% | 24681-042H |
| R30 | RES CHIP 10R 5% | 24681-042H |
| R31 | RES CHIP 10R 5% | 24681-042H |
| R32 | RES CHIP 10R 5% | 24681-042H |
| R35 | RES MF 100R 1/4W 2% | 24773-249J |
| R36 | RES CC 100R 1/8W 5% | 24331-997B |
| TR1 | TRANS FET 2N4858 40V | 28459-037F |
| TR2 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR4 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR6 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR7 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR9 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR11 | TRANS NPN SIL BFR90 15V | 28452-167U |
| Unit AB4 | - O/P PHASE DETECTOR | Issue 5 |
| 14. When ordering, prefix circuit reference with AB4 | | |
| | Complete unit | 44828-432P |
| C1 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C2 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C3 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C4 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C5 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C6 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP PETP 0.68UF 100V 10% | 26582-216E |
| C14 | CAP PETP 5.6UF 63V 10% | 26582-423E |
| C15 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C16 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C17 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C18 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB4 | - O/P PHASE DETECTOR | (Contd.) |
| C19 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C20 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C21 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C22 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C23 | CAP CER 220PF 63V 2% PLATE | 26343-481S |
| D1 | DIODE ZENER BZY88C6V2 6.2V 5% | 28371-483P |
| D2 | DIODE ZENER BZY88C6V2 6.2V 5% | 28371-483P |
| D3 | DIODE ZENER BZY88C6V2 6.2V 5% | 28371-483P |
| D4 | DIODE ZENER BZY88C6V2 6.2V 5% | 28371-483P |
| IC1 | ICD FF D 74LS74 DUAL +EDG TR | 28462-611A |
| IC2 | ICA VREG- LM304H PROG 0A025 | 28461-723R |
| IC3 | ICD CTR 74LS390 DUAL 4BIT DEC | 28464-127R |
| IC4 | ICD AND/OR 74LS51 DUAL 2-3INP | 28466-454N |
| IC5 | ICD FF D 74LS74 DUAL +EDG TR | 28462-611A |
| IC6 | ICD NAND 74LS00 QUAD 2INP | 28466-345H |
| IC7 | ICA VREG+ LM376N PROG 0A045 | 28461-725K |
| IC8 | ICA ARRAY CA3046 5 NPN TRAN | 28461-901A |
| PLBY | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLBZ | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCB | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCC | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES MF 820R 1/4W 2% | 24773-271B |
| R2 | RES MF 820R 1/4W 2% | 24773-271B |
| R3 | RES MF 820R 1/4W 2% | 24773-271B |
| R4 | RES MF 820R 1/4W 2% | 24773-271B |
| R5 | RES MF 2K4 1/4W 2% | 24773-282N |
| R6 | RES MF 5K6 1/4W 2% | 24773-291S |
| R7 | RES MF 15R 1/4W 2% | 24773-229X |
| R8 | RES MF 10K 1/4W 2% | 24773-297M |
| R9 | RES MF 62K 1/4W 2% | 24773-316Y |
| R10 | RES MF 100K 1/4W 2% | 24773-321L |
| R11 | RES MF 4K7 1/4W 2% | 24773-289W |
| R12 | RES MF 4K7 1/4W 2% | 24773-289W |
| R13 | RES MF 10K 1/4W 2% | 24773-297M |
| R14 | RES MF 62K 1/4W 2% | 24773-316Y |
| R15 | RES MF 47K 1/4W 2% | 24773-313H |
| R16 | RES MF 100K 1/4W 2% | 24773-321L |
| R17 | RES MF 1K3 1/4W 2% | 24773-276E |
| R18 | RES MF 1K8 1/4W 2% | 24773-279N |
| R19 | RES MF 5K6 1/4W 2% | 24773-291S |
| R20 | RES MF 430R 1/4W 2% | 24773-264X |
| R21 | RES MF 2K0 1/4W 2% | 24773-280U |
| R22 | RES MF 100R 1/4W 2% | 24773-249J |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB4 | - O/P PHASE DETECTOR | (Contd.) |
| R23 | RES MF 100R 1/4W 2% | 24773-249J |
| R24 | RES MF 10K 1/4W 2% | 24773-297M |
| R25 | RES MF 4K7 1/4W 2% | 24773-289W |
| R26 | RES MF 5K6 1/4W 2% | 24773-291S |
| R27 | RES MF 430R 1/4W 2% | 24773-264X |
| R28 | RES MF 2K0 1/4W 2% | 24773-280U |
| R29 | RES MF 5K6 1/4W 2% | 24773-291S |
| R30 | RES MF 430R 1/4W 2% | 24773-264X |
| R31 | RES MF 100K 1/4W 2% | 24773-321L |
| R32 | RES MF 1K3 1/4W 2% | 24773-276E |
| R33 | RES MF 1K8 1/4W 2% | 24773-279N |
| R34 | RES MF 1K0 1/4W 2% | 24773-273A |
| R35 | RES MF 1K0 1/4W 2% | 24773-273A |
| R36 | RES MF 10K 1/4W 2% | 24773-297M |
| R37 | RES MF 4K7 1/4W 2% | 24773-289W |
| R38 | RES MF 5K6 1/4W 2% | 24773-291S |
| R39 | RES MF 430R 1/4W 2% | 24773-264X |
| R40 | RES MF 100K 1/4W 2% | 24773-321L |
| R41 | RES MF 390R 1/4W 2% | 24773-263P |
| R42 | RES MF 3K9 1/4W 2% | 24773-287V |
| R43 | RES MF 1K0 1/4W 2% | 24773-273A |
| R44 | RES MF 4K7 1/4W 2% | 24773-289W |
| R45 | RES MF 10R 1/4W 2% | 24773-225W |
| R46 | RES MF 12K 1/4W 2% | 24773-299R |
| R47 | RES MF 2K2 1/4W 2% | 24773-281Y |
| R49 | RES MF 1M0 1/4W 2% | 24773-346E |
| R50 | RES MF 10K 1/4W 2% | 24773-297M |
| R51 | RES MF 10K 1/4W 2% | 24773-297M |
| R52 | RES MF 10K 1/4W 2% | 24773-297M |
| R53 | RES MF 10K 1/4W 2% | 24773-297M |
| R54 | RES MF 100R 1/4W 2% | 24773-249J |
| TR1 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR2 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR3 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR4 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR9 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR10 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR11 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR12 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR13 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR14 | TRANS PNP SIL BFR99 25V | 28433-336F |
| TR15 | TRANS PNP SIL BFR99 25V | 28433-336F |
| TR16 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR17 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB4 | - O/P PHASE DETECTOR | (Contd.) |
| TR18 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR19 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR20 | TRANS PNP SIL BFR99 25V | 28433-336F |
| TR21 | TRANS PNP SIL BFR99 25V | 28433-336F |
| TR22 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR23 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR24 | TRANS FET J310 25V | 28459-028E |
| TR25 | TRANS FET J310 25V | 28459-028E |
| TR26 | TRANS FET J310 25V | 28459-028E |
| Unit AB5 | - VCXO LOOP | Issue 3 |
| 15. When ordering, prefix circuit reference with AB5 | | |
| | Complete unit | 44828-433X |
| C1 | CAP PETP 1.0UF 100V 10% | 26582-217U |
| C2 | CAP PETP 0.22UF 100V 10% | 26582-226G |
| C3 | CAP PS 100PF 350V 2PF | 26516-243J |
| C4 | CAP PS 100PF 350V 2PF | 26516-243J |
| C5 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C6 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C7 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C17 | CAP PETP 0.22UF 100V 10% | 26582-226G |
| C18 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C19 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C20 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C21 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C22 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C23 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB5 | - VCXO LOOP | (Contd.) |
| C24 | CAP PS 100PF 350V 2PF | 26516-243J |
| C25 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C26 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C27 | CAP CER 220PF 63V 2% PLATE | 26343-481S |
| D1 | DIODE ZENER BZY88C12 12V 5% | 28372-143U |
| D2 | DIODE VAR CAP BB809 3V 29PF | 28381-132G |
| D3 | DIODE HOT CARR 1N5390 | 28349-005Z |
| D4 | DIODE ZENER BZY88C3V6 3.6V 5% | 28371-223Z |
| IC1 | ICD NOR 74LS02 QUAD 2INP | 28466-214Y |
| IC2 | ICA MOD/DMOD MC1496N BAL DIL14 | 28461-924X |
| IC3 | ICD CTR 74LS390 DUAL 4BIT DEC | 28464-127R |
| IC4 | ICD FF D 74LS74 DUAL +EDG TR | 28462-611A |
| IC5 | ICA COMP LM311N DIL8 | 28461-695U |
| IC6 | ICD NAND 74LS20 DUAL 4INP | 28466-347U |
| IC7 | ICA AMP TL071CP FET I/P DIL8 | 28461-347A |
| L1 | IND CHOKE 15UH 5% | 23642-469A |
| L2 | IND CHOKE 1.5UH 10% | 23642-550Y |
| PLCD | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCE | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCF | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES MF 150R 1/4W 2% | 24773-253F |
| R2 | RES MF 10K 1/4W 2% | 24773-297M |
| R3 | RES MF 10K 1/4W 2% | 24773-297M |
| R4 | RES MF 10K 1/4W 2% | 24773-297M |
| R5 | RES MF 1K0 1/4W 2% | 24773-273A |
| R6 | RES MF 2K0 1/4W 2% | 24773-280U |
| R7 | RES MF 2K0 1/4W 2% | 24773-280U |
| R8 | RES MF 2K0 1/4W 2% | 24773-280U |
| R9 | RES MF 15K 1/4W 2% | 24773-301P |
| R10 | RES MF 12K 1/4W 2% | 24773-299R |
| R11 | RES MF 1K0 1/4W 2% | 24773-273A |
| R12 | RES MF 150R 1/4W 2% | 24773-253F |
| R13 | RES MF 300R 1/4W 2% | 24773-260W |
| R14 | RES MF 3K9 1/4W 2% | 24773-287V |
| R15 | RES MF 3K9 1/4W 2% | 24773-287V |
| R16 | RES MF 12K 1/4W 2% | 24773-299R |
| R17 | RES MF 10K 1/4W 2% | 24773-297M |
| R18 | RES MF 2K4 1/4W 2% | 24773-282N |
| R19 | RES MF 68R 1/4W 2% | 24773-245U |
| R20 | RES MF 1K0 1/4W 2% | 24773-273A |
| R21 | RES MF 1K0 1/4W 2% | 24773-273A |
| R22 | RES MF 1K5 1/4W 2% | 24773-277U |
| R23 | RES MF 1K5 1/4W 2% | 24773-277U |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AB5 | - VCXO LOOP | (Contd.) |
| R24 | RES MF 8K2 1/4W 2% | 24773-295P |
| R25 | RES MF 2K4 1/4W 2% | 24773-282N |
| R26 | RES MF 1K0 1/4W 2% | 24773-273A |
| R27 | RES MF 1K0 1/4W 2% | 24773-273A |
| R28 | RES MF 39K 1/4W 2% | 24773-311A |
| R29 | RES MF 8K2 1/4W 2% | 24773-295P |
| R30 | RES MF 300R 1/4W 2% | 24773-260W |
| R31 | RES MF 300R 1/4W 2% | 24773-260W |
| R33 | RES MF 3K9 1/4W 2% | 24773-287V |
| R35 | RES MF 2K0 1/4W 2% | 24773-280U |
| R36 | RES MF 10K 1/4W 2% | 24773-297M |
| R37 | RES MF 10K 1/4W 2% | 24773-297M |
| TR1 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR2 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR3 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR4 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR5 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR6 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR7 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR8 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| XL1 | CRYSTAL 10.01MHZ FLYING LEADS | 28312-072R |
| Unit AC0 | - RF BOX 2 (44990-352S) | Issue 3 |

16. When ordering, prefix circuit reference with AC0

| | | |
|---|---|---|
| C1 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C2 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C3 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C4 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C5 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C6 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C7 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C8 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C9 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C10 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C11 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC0 | - RF BOX 2 | (Contd.) |
| C12 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C13 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C14 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C15 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C16 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C17 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C18 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C19 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C20 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C21 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C22 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C23 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C24 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C25 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C26 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C27 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C28 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C29 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C30 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C31 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C32 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C33 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C34 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C35 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C36 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C37 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C38 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C39 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C40 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C41 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C42 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C43 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C44 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C45 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C46 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C47 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C48 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C49 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C50 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C51 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C52 | CAP CER 50PF 300V 10% LD/T | 26333-229U |
| C53 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |
| C54 | CAP CER .001UF 300V 20%+ LD/T | 26373-733K |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC0 | - RF BOX 2 | (Contd.) |
| L1 | IND CHOKE 100UH 10% | 23642-561W |
| L2 | IND CHOKE 100UH 10% | 23642-561W |
| L3 | IND CHOKE 100UH 10% | 23642-561W |
| L4 | IND CHOKE 100UH 10% | 23642-561W |
| L5 | IND CHOKE 100UH 10% | 23642-561W |
| L6 | IND CHOKE 100UH 10% | 23642-561W |
| L7 | IND CHOKE 100UH 10% | 23642-561W |
| L8 | IND CHOKE 100UH 10% | 23642-561W |
| L9 | IND CHOKE 100UH 10% | 23642-561W |
| L10 | IND CHOKE 100UH 10% | 23642-561W |
| L11 | IND CHOKE 100UH 10% | 23642-561W |
| L12 | IND CHOKE 100UH 10% | 23642-561W |
| L13 | IND CHOKE 100UH 10% | 23642-561W |
| L14 | IND CHOKE 100UH 10% | 23642-561W |
| L15 | IND CHOKE 100UH 10% | 23642-561W |
| L16 | IND CHOKE 100UH 10% | 23642-561W |
| L17 | IND CHOKE 100UH 10% | 23642-561W |
| L18 | IND CHOKE 100UH 10% | 23642-561W |
| L19 | IND CHOKE 100UH 10% | 23642-561W |
| L20 | IND CHOKE 100UH 10% | 23642-561W |
| L21 | IND CHOKE 100UH 10% | 23642-561W |
| L22 | IND CHOKE 100UH 10% | 23642-561W |
| L23 | IND CHOKE 100UH 10% | 23642-561W |
| L24 | IND CHOKE 100UH 10% | 23642-561W |
| L34 | IND CHOKE 100UH 10% | 23642-561W |
| PLDE | CONN ASSY PLDE | 43129-687T |
| SKAW | CON RF SMB MALE 50 BKHD SOLDER | 23444-331H |
| SKAX | CON RF SMC MALE 50 BKHD SOLDER | 23444-382T |
| SKCM | CONN ASSY SKCM | 43129-680J |
| SKCN | CONN ASSY SKCN-SKDC | 43129-683V |
| SKCP | CONN ASSY SKCP-SKCZ | 43129-682G |
| SKCR | CONN ASSY SKCR | 43129-681F |
| SKCU | CONN ASSY SKCU | 43129-685W |
| SKCV | CONN ASSY SKCV | 43129-686D |
| SKDA | CONN ASSY SKDA-SKCT-SKCW | 43129-684S |
| SKDD | CONN ASSY SKDD | 43129-688P |
| X3 | FERRITE BEAD | 41372-006T |
| X4 | FERRITE BEAD | 41372-006T |
| X5 | FERRITE BEAD | 41372-006T |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC2 | - B.F.O. SYSTEM | Issue 3 |
| 17. When ordering, prefix circuit reference with AC2 | | |
| | Complete unit | 44828-435C |
| C1 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C3 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C4 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C5 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C6 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C7 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C8 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C9 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C12 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C13 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C17 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C18 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C19 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C20 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C21 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C22 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C23 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| D1 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D2 | DIODE SIL BA482 35V JUNC | 28335-675R |
| L1 | IND CHOKE 15UH 10% | 23642-556V |
| L2 | IND CHOKE 15UH 10% | 23642-556V |
| L3 | IND CHOKE 15UH 10% | 23642-556V |
| L4 | IND CHOKE 15UH 10% | 23642-556V |
| L5 | IND CHOKE 1000UH 10% | 23642-567C |
| PLCU | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCV | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCW | CON PART PCB POST SQUARE PIN | 23435-188V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC2 | - B.F.O. SYSTEM | (Contd.) |
| R1 | RES MF 51R 1/4W 2% | 24773-242Z |
| R2 | RES MF 10K 1/4W 2% | 24773-297M |
| R3 | RES MF 10K 1/4W 2% | 24773-297M |
| R4 | RES MF 270R 1/4W 2% | 24773-259T |
| R5 | RES MF 470R 1/4W 2% | 24773-265M |
| R6 | RES MF 18R 1/4W 2% | 24773-231P |
| R7 | RES MF 10K 1/4W 2% | 24773-297M |
| R8 | RES MF 10K 1/4W 2% | 24773-297M |
| R9 | RES MF 1K8 1/4W 2% | 24773-279N |
| R10 | RES MF 220R 1/4W 2% | 24773-257W |
| R11 | RES MF 680R 1/4W 2% | 24773-269K |
| R12 | RES MF 51R 1/4W 2% | 24773-242Z |
| R13 | RES MF 560R 1/4W 2% | 24773-267R |
| R14 | RES MF 91R 1/4W 2% | 24773-248L |
| R15 | RES MF 10K 1/4W 2% | 24773-297M |
| R16 | RES MF 1K5 1/4W 2% | 24773-277U |
| R17 | RES MF 220R 1/4W 2% | 24773-257W |
| R18 | RES MF 1KO 1/4W 2% | 24773-273A |
| R19 | RES MF 330R 1/4W 2% | 24773-261D |
| R20 | RES MF 1KO 1/4W 2% | 24773-273A |
| TR1 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR2 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR3 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| T1 | CORE BEAD .079X.158X.197LG | 23635-833X |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD (2018 only) | Issue 7 |
| 18.. | When ordering, prefix circuit reference with AC3 | |
| | Complete unit | 44828-436R |
| C1 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C3 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C4 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C5 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C6 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C7 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C8 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C9 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.047UF 25V 20% DISC | 26383-017U |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C18 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C19 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C20 | CAP CER 8.2PF 63V .5PF PLATE | 26343-464Z |
| C21 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C22 | CAP CER 8.2PF 63V .5PF PLATE | 26343-464Z |
| C23 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C24 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C25 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C26 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C27 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C28 | CAP CER 6.8PF 63V .5PF PLATE | 26343-463A |
| C29 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C30 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C31 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C32 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C33 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C34 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C35 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C36 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C37 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C38 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C39 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C40 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C41 | CAP CER 68PF 63V 2% PLATE | 26343-475F |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD (Contd.) | |
| C42 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C43 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C44 | CAP CER 82PF 63V 2% PLATE | 26343-476G |
| C45 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C46 | CAP CER 82PF 63V 2% PLATE | 26343-476G |
| C47 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C48 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C49 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C50 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C51 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C52 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C53 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C54 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C55 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| C56 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C58 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C59 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C60 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C61 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C62 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C63 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C64 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C65 | CAP CER 120PF 63V 2% PLATE | 26343-478S |
| C66 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C67 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C68 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C69 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C70 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C71 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C72 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C73 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C74 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C75 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C76 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C77 | CAP CER 390PF 63V 10% PLATE | 26383-598Y |
| C78 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C79 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C80 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C81 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C82 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C83 | CAP CER 820PF 63V 10% PLATE | 26383-584X |
| C84 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C85 | CAP CER 560PF 63V 10% PLATE | 26383-581D |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD | (Contd.) |
| C86 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C87 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C88 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C89 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C90 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C91 | CAP CER 82PF 63V 2% PLATE | 26343-476G |
| C92 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C93 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C94 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C95 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C96 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C97 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C98 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C99 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C100 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C101 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C102 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C103 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C104 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C132 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C144 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| D1 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D2 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D3 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D4 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D6 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D7 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D8 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D9 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D10 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D11 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D12 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D13 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D14 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D15 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D16 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D17 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D18 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D19 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D20 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D21 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D22 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D23 | DIODE SIL BA482 35V JUNC | 28335-675R |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD | (Contd.) |
| D24 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D25 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D26 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D27 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D28 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D30 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D32 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D33 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D34 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D35 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D36 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D37 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D38 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D39 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D40 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D41 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D42 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D43 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D44 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D45 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D46 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D47 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D49 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D50 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D51 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D52 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D53 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D74 | DIODE HOT CARR 1N5390 | 28349-005Z |
| D75 | DIODE HOT CARR 1N5390 | 28349-005Z |
| IC1 | ICD DEC/DMX 74LS138 3-8 | 28465-027F |
| IC2 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC3 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC4 | ICD BUFF 7407 HEX O/C | 28469-703X |
| IC5 | ICD INV 7405A HEX O/C | 28469-157K |
| L1 | IND CHOKE 68UH 10% | 23642-560S |
| L2 | IND CHOKE 4.7UH 10% | 23642-553J |
| L3 | IND CHOKE 68UH 10% | 23642-560S |
| L4 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L5 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L6 | PRINTED COIL | |
| L7 | PRINTED COIL | |
| L8 | IND CHOKE 4.7UH 10% | 23642-553J |
| L9 | IND CHOKE 4.7UH 10% | 23642-553J |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD | (Contd.) |
| L10 | IND CHOKE 4.7UH 10% | 23642-553J |
| L11 | IND CHOKE 4.7UH 10% | 23642-553J |
| L12 | IND CHOKE 4.7UH 10% | 23642-553J |
| L13 | ADJ. IND. 30NH 1 3/4 T | 44290-799W |
| L14 | ADJ. IND. 30NH 1 3/4 T | 44290-799W |
| L15 | ADJ. IND. 43NH 2 1/4 T | 44290-800J |
| L16 | ADJ. IND. 43NH 2 1/4 T | 44290-800J |
| L17 | ADJ. IND. 61NH 2 3/4 T | 44290-801F |
| L18 | ADJ. IND. 61NH 2 3/4 T | 44290-801F |
| L19 | ADJ. IND. 86NH 3 3/4 T | 44290-802G |
| L20 | ADJ. IND. 86NH 3 3/4 T | 44290-802G |
| L21 | ADJ. IND. 121NH 4 3/4 T | 44290-803V |
| L22 | ADJ. IND. 121NH 4 3/4 T | 44290-803V |
| L23 | ADJ. IND. 172NH 6 3/4 T | 44290-804S |
| L24 | ADJ. IND. 172NH 6 3/4 T | 44290-804S |
| L25 | IND CHOKE 4.7UH 10% | 23642-553J |
| L26 | IND CHOKE 4.7UH 10% | 23642-553J |
| L27 | IND CHOKE 4.7UH 10% | 23642-553J |
| L28 | IND CHOKE 4.7UH 10% | 23642-553J |
| L30 | PRINTED COIL | |
| L31 | PRINTED COIL | |
| L33 | IND CHOKE 4.7UH 10% | 23642-553J |
| L34 | IND CHOKE 4.7UH 10% | 23642-553J |
| L36 | IND CHOKE 4.7UH 10% | 23642-553J |
| L37 | IND CHOKE 68UH 10% | 23642-560S |
| L38 | IND CHOKE 68UH 10% | 23642-560S |
| L39 | IND CHOKE 68UH 10% | 23642-560S |
| L40 | IND CHOKE 68UH 10% | 23642-560S |
| L41 | IND CHOKE 1.8UH 5% | 23642-495X |
| L42 | IND CHOKE 1.8UH 5% | 23642-495X |
| L43 | IND CHOKE 3.0UH 5% | 23642-474H |
| L44 | IND CHOKE 3.0UH 5% | 23642-474H |
| L45 | IND CHOKE 4.3UH 5% | 23642-466R |
| L46 | IND CHOKE 4.3UH 5% | 23642-466R |
| L47 | IND CHOKE 6.2UH 5% | 23642-455S |
| L48 | IND CHOKE 6.2UH 5% | 23642-455S |
| L49 | IND CHOKE 8.2UH 5% | 23642-468K |
| L50 | IND CHOKE 8.2UH 5% | 23642-468K |
| L51 | IND CHOKE 12UH 5% | 23642-456W |
| L52 | IND CHOKE 12UH 5% | 23642-456W |
| L53 | IND CHOKE 68UH 10% | 23642-560S |
| L54 | IND CHOKE 68UH 10% | 23642-560S |
| L55 | IND CHOKE 68UH 10% | 23642-560S |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD | (Contd.) |
| L56 | IND CHOKE 68UH 10% | 23642-560S |
| L57 | IND CHOKE 68UH 10% | 23642-560S |
| L58 | IND CHOKE 1.5UH 5% | 23642-494P |
| L59 | IND CHOKE 1.5UH 5% | 23642-494P |
| L60 | IND CHOKE 68UH 10% | 23642-560S |
| L61 | IND CHOKE 68UH 10% | 23642-560S |
| L62 | IND CHOKE 68UH 10% | 23642-560S |
| L63 | IND CHOKE 0.82UH 5% | 23642-454B |
| L64 | IND CHOKE 0.82UH 5% | 23642-454B |
| L65 | IND CHOKE 68UH 10% | 23642-560S |
| L66 | IND CHOKE 68UH 10% | 23642-560S |
| L90 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L91 | RES. LEAD LENGTH | |
| L92 | RES. LEAD LENGTH | |
| PLCM | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCN | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCP | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCR | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCT | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLDF | CONN ASSY | 43129-537Y |
| R1 | RES MF 360R 1/4W 2% | 24773-262T |
| R2 | RES MF 1K0 1/4W 2% | 24773-273A |
| R3 | RES MF 470R 1/4W 2% | 24773-265M |
| R4 | RES MF 3K0 1/4W 2% | 24773-284J |
| R5 | RES MF 3K0 1/4W 2% | 24773-284J |
| R6 | RES MF 75R 1/4W 2% | 24773-246Y |
| R7 | RES MF 1K5 1/4W 2% | 24773-277U |
| R8 | RES CC 150R 1/8W 5% | 24331-990D |
| R9 | RES CC 150R 1/8W 5% | 24331-990D |
| R10 | RES CHIP 16R 5% | 24681-043E |
| R11 | RES CHIP 16R 5% | 24681-043E |
| R12 | RES MF 51R 1/4W 2% | 24773-242Z |
| R13 | RES MF 51R 1/4W 2% | 24773-242Z |
| R14 | RES MF 6K8 1/4W 2% | 24773-293D |
| R15 | RES MF 6K8 1/4W 2% | 24773-293D |
| R16 | RES MF 200R 1/4W 2% | 24773-256S |
| R17 | RES MF 820R 1/4W 2% | 24773-271B |
| R18 | RES MF 75R 1/4W 2% | 24773-246Y |
| R19 | RES MF 2K4 1/4W 2% | 24773-282N |
| R20 | RES MF 820R 1/4W 2% | 24773-271B |
| R21 | RES MF 820R 1/4W 2% | 24773-271B |
| R22 | RES MF 3K9 1/4W 2% | 24773-287V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC3 | - FILTER BOARD | (Contd.) |
| R23 | RES MF 360R 1/4W 2% | 24773-262T |
| R24 | RES MF 470R 1/4W 2% | 24773-265M |
| R25 | RES MF 5K6 1/4W 2% | 24773-291S |
| R26 | RES MF 300R 1/4W 2% | 24773-260W |
| R27 | RES MF 300R 1/4W 2% | 24773-260W |
| R28 | RES MF 6K8 1/4W 2% | 24773-293D |
| R29 | RES MF 270R 1/4W 2% | 24773-259T |
| R30 | RES MF 240R 1/4W 2% | 24773-258D |
| R31 | RES MF 10K 1/4W 2% | 24773-297M |
| R32 | RES MF 240R 1/4W 2% | 24773-258D |
| R33 | RES MF 1K0 1/4W 2% | 24773-273A |
| R34 | RES MF 470R 1/4W 2% | 24773-265M |
| R35 | RES MF 1K5 1/4W 2% | 24773-277U |
| R36 | RES MF 470R 1/4W 2% | 24773-265M |
| R37 | RES MF 1K0 1/4W 2% | 24773-273A |
| R38 | RES MF 470R 1/4W 2% | 24773-265M |
| R39 | RES MF 1K0 1/4W 2% | 24773-273A |
| R40 | RES MF 470R 1/4W 2% | 24773-265M |
| R42 | RES MF 470R 1/4W 2% | 24773-265M |
| R43 | RES MF 680R 1/4W 2% | 24773-269K |
| R44 | RES MF 680R 1/4W 2% | 24773-269K |
| R45 | RES MF 680R 1/4W 2% | 24773-269K |
| R46 | RES MF 680R 1/4W 2% | 24773-269K |
| R47 | RES MF 1K0 1/4W 2% | 24773-273A |
| R48 | RES MF 470R 1/4W 2% | 24773-265M |
| R50 | RES MF 470R 1/4W 2% | 24773-265M |
| R51 | RES MF 1K0 1/4W 2% | 24773-273A |
| R52 | RES MF 470R 1/4W 2% | 24773-265M |
| R53 | RES MF 1K0 1/4W 2% | 24773-273A |
| R54 | RES MF 1K5 1/4W 2% | 24773-277U |
| R55 | RES MF 470R 1/4W 2% | 24773-265M |
| R56 | RES MF 470R 1/4W 2% | 24773-265M |
| R57 | RES MF 470R 1/4W 2% | 24773-265M |
| R92 | RES MF 1K0 1/4W 2% | 24773-273A |
| R93 | RES MF 470R 1/4W 2% | 24773-265M |
| SKCS | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| TR1 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR2 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR3 | TRANS NPN SIL 2N2369 15V | 28452-197H |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | Issue 4 |
| 19. | When ordering, prefix circuit reference with AC4 | |
| | Complete unit | 44828-439A |
| C1 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C2 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C3 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C4 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C5 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C6 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C7 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C8 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C9 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C10 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C11 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C12 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C13 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C14 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C15 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C16 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C17 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C18 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C19 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C20 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C21 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| C22 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C23 | CAP CER 10PF 50V 5% CHIP | 26343-767B |
| C24 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C25 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C26 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C27 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C28 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C29 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C30 | CAP CER .1UF 50V 20%+ CHIP | 26386-496S |
| C31 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C32 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C33 | CAP CER .01UF 100V 20% CHIP | 26386-494G |
| C34 | CAP CER .01UF 100V 20% CHIP | 26386-494G |
| C35 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C36 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C37 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C38 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C39 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C40 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | (Contd.) |
| C41 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C42 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C43 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C44 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C45 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C46 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C47 | CAP PETP 0.1UF 100V 10% | 26582-211B |
| C48 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C49 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C50 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C51 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C52 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C53 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C54 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C55 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C56 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C57 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C58 | CAP PETP 0.01UF 400V 10% | 26582-232W |
| C59 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C60 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C61 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C62 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| D1 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D2 | DIODE PIN 5082-3379 50V | 28383-997T |
| D3 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D4 | DIODE PIN 5082-3379 50V | 28383-997T |
| D5 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D6 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D7 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D8 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D9 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D10 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D11 | DIODE HOT CARR HP5082-2826 | 28349-011U |
| D12 | DIODE HOT CARR HP5082-2826 | 28349-011U |
| D13 | DIODE HOT CARR HP5082-2826 | 28349-011U |
| D14 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D15 | DIODE SIL 1N4448 75V JUNC | 28336-246M |
| D16 | DIODE HOT CARR HP5082-2826 | 28349-011U |
| D17 | DIODE HOT CARR HP5082-2826 | 28349-011U |
| D18 | DIODE PIN 5082-3379 50V | 28383-997T |
| D19 | DIODE PIN 5082-3379 50V | 28383-997T |
| IC1 | ICA AMP TL074CN QUAD FET I/P | 28461-349H |

| Circuit Ref | Description | | Part Number |
|---|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | | (Contd.) |
| IC2 | ICD FF D 7474 DUAL +EDG TR | | 28462-002N |
| IC3 | ICA AMP TL074CN QUAD FET I/P | | 28461-349H |
| IC4 | ICA DAC AD7524JN 8BIT | ! | 28469-400R |
| IC5 | ICD INV 74LS04 HEX | | 28469-171L |
| IC6 | ICA DAC AD7522LN 10BIT MOS | ! | 28469-402K |
| L1 | RES. LEAD LENGTH | | |
| L2 | PRINTED COIL | | |
| L3 | RES. LEAD LENGTH | | |
| L4 | PRINTED COIL | | |
| L5 | RES. LEAD LENGTH | | |
| L6 | 6-HOLE FERRITE, 2.4UH INDUCTOR | | 44290-790U |
| L7 | PRINTED COIL | | |
| L8 | IND CHOKE 1000UH 10% .18A | | 23642-620Y |
| L9 | 6-HOLE FERRITE, 2.4UH INDUCTOR | | 44290-790U |
| L10 | 6-HOLE FERRITE, 2.4UH INDUCTOR | | 44290-790U |
| L11 | IND CHOKE 1000UH 10% | | 23642-567C |
| L12 | IND CHOKE 1000UH 10% | | 23642-567C |
| L13 | IND CHOKE 1000UH 10% | | 23642-567C |
| PLCS | CONN ASSY | | 43129-668H |
| PLCZ | CON PART PCB POST SQUARE PIN | | 23435-188V |
| PLDA | CON PART PCB POST SQUARE PIN | | 23435-188V |
| R1 | RES MF 750R 1/4W 2% | | 24773-270R |
| R2 | RES MF 10K 1/4W 2% | | 24773-297M |
| R3 | RES MF 620R 1/4W 2% | | 24773-268B |
| R4 | RES MF 2K7 1/4W 2% | | 24773-283L |
| R5 | RES MF 33R 1/4W 2% | | 24773-237K |
| R6 | RES MF 240R 1/4W 2% | | 24773-258D |
| R7 | RES CC 200R 1/8W 5% | | 24331-999A |
| R8 | RES CHIP 16R 5% | | 24681-043E |
| R9 | RES CHIP 22R 5% | | 24681-044U |
| R10 | RES MF 750R 1/4W 2% | | 24773-270R |
| R11 | RES MF 10K 1/4W 2% | | 24773-297M |
| R12 | RES MF 620R 1/4W 2% | | 24773-268B |
| R13 | RES MF 620R 1/4W 2% | | 24773-268B |
| R14 | RES MF 2K7 1/4W 2% | | 24773-283L |
| R15 | RES MF 33R 1/4W 2% | | 24773-237K |
| R16 | RES MF 240R 1/4W 2% | | 24773-258D |
| R17 | RES CC 200R 1/8W 5% | | 24331-999A |
| R18 | RES CHIP 16R 5% | | 24681-043E |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | (Contd.) |
| R19 | RES CHIP 22R 5% | 24681-044U |
| R20 | RES MF 620R 1/4W 2% | 24773-268B |
| R21 | RES MF 620R 1/4W 2% | 24773-268B |
| R22 | RES MF 3K3 1/4W 2% | 24773-285F |
| R23 | RES MF 10K 1/4W 2% | 24773-297M |
| R24 | RES MF 10K 1/4W 2% | 24773-297M |
| R25 | RES MF 150R 1/4W 2% | 24773-253F |
| R26 | RES CHIP 22R 5% | 24681-044U |
| R27 | RES MF 750R 1/4W 2% | 24773-270R |
| R28 | RES MF 10K 1/4W 2% | 24773-297M |
| R29 | RES MF 2K7 1/4W 2% | 24773-283L |
| R30 | RES CC 82R 1/8W 5% | 24331-996R |
| R31 | RES MF 22R 1/4W 2% | 24773-233M |
| R32 | RES MO 150R 1/2W 2% | 24573-053K |
| R33 | RES CHIP 16R 5% | 24681-043E |
| R34 | RES CHIP 16R 5% | 24681-043E |
| R35 | RES CHIP 16R 5% | 24681-043E |
| R36 | RES MF 1K0 1/4W 2% | 24773-273A |
| R37 | RES MF 15K 1/4W 2% | 24773-301P |
| R38 | RES MF 1K0 1/4W 2% | 24773-273A |
| R39 | RES MF 10R 1/4W 2% | 24773-225W |
| R40 | RES CHIP 16R 5% | 24681-043E |
| R41 | RES CHIP 16R 5% | 24681-043E |
| R42 | RES MF 200R 1/4W 2% | 24773-256S |
| R43 | RES MG 4M7 1/4W 5% | 24321-881F |
| R44 | RES MF 1K0 1/4W 2% | 24773-273A |
| R45 | RES MG 4M7 1/4W 5% | 24321-881F |
| R46 | RES MG 4M7 1/4W 5% | 24321-881F |
| R47 | RES MF 50R0 1/4W 1% N-I | 24762-558R |
| R48 | RES MF 10K 1/4W 2% | 24773-297M |
| R49 | RES MF 200R 1/4W 2% | 24773-256S |
| R50 | RES MF 10K 1/4W 2% | 24773-297M |
| R51 | RES MF 820R 1/4W 2% | 24773-271B |
| R52 | RES MF 27R 1/4W 2% | 24773-235R |
| R53 | RES MF 10K 1/4W 2% | 24773-297M |
| R54 | RES MF 200R 1/4W 2% | 24773-256S |
| R55 | RES MF 10K 1/4W 2% | 24773-297M |
| R56 | RES MF 10K 1/4W 2% | 24773-297M |
| R57 | RES MF 10K 1/4W 2% | 24773-297M |
| R58 | RES MF 820R 1/4W 2% | 24773-271B |
| R59 | RES MF 27R 1/4W 2% | 24773-235R |
| R60 | RES MF 10K 1/4W 2% | 24773-297M |
| R61 | RES MF 10K 1/4W 2% | 24773-297M |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | (Contd.) |
| R62 | RES MF 10K 1/4W 2% | 24773-297M |
| R63 | RES MF 1K0 1/4W 2% | 24773-273A |
| R64 | RES MF 200R 1/4W 2% | 24773-256S |
| R65 | RES MF 3K3 1/4W 2% | 24773-285F |
| R66 | RES MF 150R 1/4W 2% | 24773-253F |
| R67 | RES MF 51R 1/4W 2% | 24773-242Z |
| R68 | RES MF 15K 1/4W 2% | 24773-301P |
| R69 | RES MF 30K 1/4W 2% | 24773-308A |
| R70 | RES MF 15K 1/4W 2% | 24773-301P |
| R71 | RES MF 10K 1/4W 2% | 24773-297M |
| R72 | RES MF 3K3 1/4W 2% | 24773-285F |
| R73 | RES MF 10K 1/4W 2% | 24773-297M |
| R74 | RES MF 33K 1/4W 2% | 24773-309Z |
| R75 | RES MF 33K 1/4W 2% | 24773-309Z |
| R76 | RES NET 10K 5% 8DIL DIL | 24681-511P |
| R77 | RV CERM 1K0 LIN .5W 10% HORZ | 25711-638G |
| R78 | RES MF 2K0 1/4W 2% | 24773-280U |
| R79 | RES MF 15K 1/4W 2% | 24773-301P |
| R80 | RES MF 2K0 1/4W 2% | 24773-280U |
| R81 | RES MF 10K 1/4W 2% | 24773-297M |
| R82 | RES MF 1K5 1/4W 2% | 24773-277U |
| R84 | RES MF 3K0 1/4W 2% | 24773-284J |
| R85 | RES MF 3K3 1/4W 2% | 24773-285F |
| R86 | RV CERM 500R LIN .5W 10% HORZ | 25711-637F |
| R87 | RES MF 150R 1/4W 2% | 24773-253F |
| R89 | RV CERM 50K LIN .5W 10% HORZ | 25711-643S |
| R90 | RES MF 22K 1/4W 2% | 24773-305R |
| R91 | RES MG 3M3 1/4W 5% | 24321-879G |
| R92 | RES MG 3M3 1/4W 5% | 24321-879G |
| R93 | RES MF 1K0 1/4W 2% | 24773-273A |
| R94 | RES MF 10K 1/4W 2% | 24773-297M |
| R95 | RV CERM 10K LIN .5W 10% HORZ | 25711-641G |
| R96 | RES MF 8K2 1/4W 2% | 24773-295P |
| R97 | RES MF 2K7 1/4W 2% | 24773-283L |
| R98 | RES MF 620R 1/4W 2% | 24773-268B |
| SKAY | CONN ASSY SKAY | 43129-679G |
| TR1 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR2 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR3 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR4 | TRANS NPN SIL BFR91 12V | 28451-696U |
| TR5 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR6 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC4 | - OUTPUT AMPLIFIER | (Contd.) |
| TR7 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR8 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR9 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR10 | TRANS NPN SIL BFQ34 18V | 28452-247V |
| TR11 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR12 | TRANS FET J310 25V | 28459-028E |
| TR13 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR14 | TRANS FET J310 25V | 28459-028E |
| TR15 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR16 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR17 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| Unit AC5 | - AMPLITUDE MODULATOR | Issue 4 |
| 20. | When ordering, prefix circuit reference with AC5 | |
| | Complete unit | 44828-440B |
| C1 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C2 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C3 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C4 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C5 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C6 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C7 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C8 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C9 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C10 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C11 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C12 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| IC1 | MOD HYB OM345 VHF/UHF AMP SIL | 28461-351Z |
| IC2 | ICD FF D 7474 DUAL +EDG TR | 28462-002N |
| IC3 | ICA AMP TL071CP FET I/P DIL8 | 28461-347A |
| IC4 | ICA DAC AD7524JN 8BIT ! | 28469-400R |
| PLDC | CON PART PCB POST SQUARE PIN | 23435-188V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC5 | - AMPLITUDE MODULATOR | (Contd.) |
| PLDD | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES CC 51R 1/8W 5% | 24331-989P |
| R2 | RES CC 270R 1/8W 5% | 24331-992P |
| R3 | RES CHIP 16R 5% | 24681-043E |
| R4 | RES CC 270R 1/8W 5% | 24331-992P |
| R5 | RES MF 330R 1/4W 2% | 24773-261D |
| R6 | RES CC 22R 1/8W 5% | 24331-988T |
| R7 | RES CC 51R 1/8W 5% | 24331-989P |
| R8 | RES MF 5K1 1/4W 2% | 24773-290V |
| R9 | RES MF 10K 1/4W 2% | 24773-297M |
| R10 | RES MF 240R 1/4W 2% | 24773-258D |
| R11 | RES MF 240R 1/4W 2% | 24773-258D |
| R12 | RES CHIP 16R 5% | 24681-043E |
| R13 | RES MF 3K6 1/4W 2% | 24773-286G |
| R14 | RES MF 510R 1/4W 2% | 24773-266C |
| R15 | RES MF 330R 1/4W 2% | 24773-261D |
| R16 | RES NET 10K 5% 8DIL DIL | 24681-511P |
| R17 | RES MF 10K 1/4W 2% | 24773-297M |
| R18 | RES MF 3K0 1/4W 2% | 24773-284J |
| R20 | RES MF 10K 1/4W 2% | 24773-297M |
| R21 | RES MF 18K 1/4W 2% | 24773-303M |
| R22 | RES MF 18K 1/4W 2% | 24773-303M |
| R23 | RV CERM 500R LIN .5W 10% HORZ | 25711-637F |
| SKDE | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| SKDF | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| TR1 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR2 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR3 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| X1 | MIXER SBL1 DOUBLE BAL DIODE | 28531-002A |
| X2 | MIXER TFM2 DOUBLE BAL | 28531-003Z |

Unit AC13 -FILTER & FREQ DOUBLER BOARD (2019 only)Issue 10

21. When ordering, prefix circuit reference with AC13

| | | |
|---|---|---|
| | Complete unit | 44828-437B |
| C1 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C3 | CAP CER .039UF 50V 20% CHIP | 26386-493F |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| C4 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C5 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C6 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C7 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C8 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C9 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C10 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C11 | CAP CER 0.047UF 25V 20% DISC | 26383-017U |
| C12 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C13 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C14 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C15 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C18 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C19 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C20 | CAP CER 8.2PF 63V .5PF PLATE | 26343-464Z |
| C21 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C22 | CAP CER 8.2PF 63V .5PF PLATE | 26343-464Z |
| C23 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C24 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C25 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C26 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C27 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C28 | CAP CER 6.8PF 63V .5PF PLATE | 26343-463A |
| C29 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C30 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C31 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C32 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C33 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C34 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C35 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C36 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C37 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C38 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C39 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C40 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C41 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C42 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C43 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C44 | CAP CER 82PF 63V 2% PLATE | 26343-476G |
| C45 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C46 | CAP CER 82PF 63V 2% PLATE | 26343-476G |
| C47 | CAP CER .001UF 63V 10% PLATE | 26383-585M |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD (Contd.) | |
| C48 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C49 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C50 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C51 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C52 | CAP CER 18PF 63V 5% PLATE | 26343-468Y |
| C53 | CAP CER 12PF 63V 5% PLATE | 26343-466E |
| C54 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C55 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| C56 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C57 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C58 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C59 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C60 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C61 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C62 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C63 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C64 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C65 | CAP CER 120PF 63V 2% PLATE | 26343-478S |
| C66 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C67 | CAP CER 100PF 63V 2% PLATE | 26343-477V |
| C68 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C69 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C70 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C71 | CAP CER 150PF 63V 2% PLATE | 26343-479W |
| C72 | CAP CER 22PF 63V 5% PLATE | 26343-469N |
| C73 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C74 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C75 | CAP CER 180PF 63V 2% PLATE | 26343-480V |
| C76 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C77 | CAP CER 390PF 63V 10% PLATE | 26383-598Y |
| C78 | CAP CER 270PF 63V 2% PLATE | 26343-482W |
| C79 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C80 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C81 | CAP CER 470PF 63V 10% PLATE | 26383-582T |
| C82 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C83 | CAP CER 820PF 63V 10% PLATE | 26383-584X |
| C84 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C85 | CAP CER 560PF 63V 10% PLATE | 26383-581D |
| C86 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C87 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C88 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C89 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C90 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C91 | CAP CER 82PF 63V 2% PLATE | 26343-476G |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| C92 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C93 | CAP CER 33PF 63V 5% PLATE | 26343-471Y |
| C94 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C95 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C96 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C97 | CAP CER 68PF 63V 2% PLATE | 26343-475F |
| C98 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C99 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C100 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C101 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C102 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C103 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C104 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| C106 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C107 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C108 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C109 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C110 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C111 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C112 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C113 | CAP CER 10PF 63V .5PF PLATE | 26343-465H |
| C114 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C115 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C116 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C117 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C118 | CAP CER 2.7PF 63V .5PF PLATE | 26343-458B |
| C119 | CAP CER 15PF 63V 5% PLATE | 26343-467U |
| C120 | CAP CER 8.2PF 63V .5PF PLATE | 26343-464Z |
| C121 | CAP CER 1.0PF 63V .5P PLATE | 26343-502Z |
| C122 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C123 | CAP CER 10PF 63V .5PF PLATE | 26343-465H |
| C124 | CAP CER 5.6PF 63V .5PF PLATE | 26343-462K |
| C125 | CAP CER 1.0PF 63V .5P PLATE | 26343-502Z |
| C126 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C127 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C128 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C129 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C130 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C131 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C132 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C135 | CAP CER 3.3PF 63V .5PF PLATE | 26343-459K |
| C136 | UNCL PRINTED CAP | |
| C137 | CAP CER 5.6PF 63V .5PF PLATE | 26343-462K |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| C138 | CAP CER 2.7PF 63V .5PF PLATE | 26343-458B |
| C139 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C140 | CAP CER 3.9PF 63V .5PF PLATE | 26343-460R |
| C141 | CAP CER 2.2PF 63V .5PF PLATE | 26343-457R |
| C142 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C143 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C144 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C145 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C146 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C147 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C148 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| C149 | CAP CER 2.7PF 63V .5PF PLATE | 26343-458B |
| C151 | CAP CER 4.7PF 63V .5PF PLATE | 26343-461B |
| C152 | CAP CER .001UF 63V 10% PLATE | 26383-585M |
| D1 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D2 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D3 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D4 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D5 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D6 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D7 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D8 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D9 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D10 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D11 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D12 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D13 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D14 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D15 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D16 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D17 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D18 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D19 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D20 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D21 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D22 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D23 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D24 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D25 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D26 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D27 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D28 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D29 | DIODE SIL BA482 35V JUNC | 28335-675R |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| D30 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D31 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D32 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D33 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D34 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D35 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D36 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D37 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D38 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D39 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D40 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D41 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D42 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D43 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D44 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D45 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D46 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D47 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D49 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D50 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D51 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D52 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D53 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D54 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D55 | DIODE 5082-2080 | |
| D56 | DIODE 5082-2080 Set of three | 44529-058G |
| D57 | DIODE 5082-2080 | |
| D58 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D59 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D60 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D61 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D62 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D63 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D64 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D65 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D66 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D67 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D68 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D69 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D70 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D71 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D72 | DIODE SIL BA482 35V JUNC | 28335-675R |
| D73 | DIODE SIL BA482 35V JUNC | 28335-675R |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| D74 | DIODE HOT CARR 1N5390 | 28349-005Z |
| D75 | DIODE HOT CARR 1N5390 | 28349-005Z |
| IC1 | ICD DEC/DMX 74LS138 3-8 | 28465-027F |
| IC2 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC3 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC4 | ICD BUFF 7407 HEX O/C | 28469-703X |
| IC5 | ICD INV 7405A HEX O/C | 28469-157K |
| IC6 | ICD FF D 74LS175 QUAD +EDG TR | 28462-614E |
| IC7 | ICD BUFF 7407 HEX O/C | 28469-703X |
| IC8 | ICA AMP UA741CN GP DIL8 | 28461-304T |
| L1 | IND CHOKE 68UH 10% | 23642-560S |
| L2 | IND CHOKE 4.7UH 10% | 23642-553J |
| L3 | IND CHOKE 68UH 10% | 23642-560S |
| L4 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L5 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L6 | PRINTED COIL | |
| L7 | PRINTED COIL | |
| L8 | IND CHOKE 4.7UH 10% | 23642-553J |
| L9 | IND CHOKE 4.7UH 10% | 23642-553J |
| L10 | IND CHOKE 4.7UH 10% | 23642-553J |
| L11 | IND CHOKE 4.7UH 10% | 23642-553J |
| L12 | IND CHOKE 4.7UH 10% | 23642-553J |
| L13 | ADJ. IND. 30NH 1 3/4 T | 44290-799W |
| L14 | ADJ. IND. 30NH 1 3/4 T | 44290-799W |
| L15 | ADJ. IND. 43NH 2 1/4 T | 44290-800J |
| L16 | ADJ. IND. 43NH 2 1/4 T | 44290-800J |
| L17 | ADJ. IND. 61NH 2 3/4 T | 44290-801F |
| L18 | ADJ. IND. 61NH 2 3/4 T | 44290-801F |
| L19 | ADJ. IND. 86NH 3 3/4 T | 44290-802G |
| L20 | ADJ. IND. 86NH 3 3/4 T | 44290-802G |
| L21 | ADJ. IND. 121NH 4 3/4 T | 44290-803V |
| L22 | ADJ. IND. 121NH 4 3/4 T | 44290-803V |
| L23 | ADJ. IND. 172NH 6 3/4 T | 44290-804S |
| L24 | ADJ. IND. 172NH 6 3/4 T | 44290-804S |
| L25 | IND CHOKE 4.7UH 10% | 23642-553J |
| L26 | IND CHOKE 4.7UH 10% | 23642-553J |
| L27 | IND CHOKE 4.7UH 10% | 23642-553J |
| L28 | IND CHOKE 4.7UH 10% | 23642-553J |
| L30 | PRINTED COIL | |
| L31 | PRINTED COIL | |
| L33 | IND CHOKE 4.7UH 10% | 23642-553J |
| L34 | IND CHOKE 4.7UH 10% | 23642-553J |
| L36 | IND CHOKE 4.7UH 10% | 23642-553J |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| L37 | IND CHOKE 68UH 10% | 23642-560S |
| L38 | IND CHOKE 68UH 10% | 23642-560S |
| L39 | IND CHOKE 68UH 10% | 23642-560S |
| L40 | IND CHOKE 68UH 10% | 23642-560S |
| L41 | IND CHOKE 1.8UH 5% | 23642-495X |
| L42 | IND CHOKE 1.8UH 5% | 23642-495X |
| L43 | IND CHOKE 3.0UH 5% | 23642-474H |
| L44 | IND CHOKE 3.0UH 5% | 23642-474H |
| L45 | IND CHOKE 4.3UH 5% | 23642-466R |
| L46 | IND CHOKE 4.3UH 5% | 23642-466R |
| L47 | IND CHOKE 6.2UH 5% | 23642-455S |
| L48 | IND CHOKE 6.2UH 5% | 23642-455S |
| L49 | IND CHOKE 8.2UH 5% | 23642-468K |
| L50 | IND CHOKE 8.2UH 5% | 23642-468K |
| L51 | IND CHOKE 12UH 5% | 23642-456W |
| L52 | IND CHOKE 12UH 5% | 23642-456W |
| L53 | IND CHOKE 68UH 10% | 23642-560S |
| L54 | IND CHOKE 68UH 10% | 23642-560S |
| L55 | IND CHOKE 68UH 10% | 23642-560S |
| L56 | IND CHOKE 68UH 10% | 23642-560S |
| L57 | IND CHOKE 68UH 10% | 23642-560S |
| L58 | IND CHOKE 1.5UH 5% | 23642-494P |
| L59 | IND CHOKE 1.5UH 5% | 23642-494P |
| L60 | IND CHOKE 68UH 10% | 23642-560S |
| L61 | IND CHOKE 68UH 10% | 23642-560S |
| L62 | IND CHOKE 68UH 10% | 23642-560S |
| L63 | IND CHOKE 0.82UH 5% | 23642-454B |
| L64 | IND CHOKE 0.82UH 5% | 23642-454B |
| L65 | IND CHOKE 68UH 10% | 23642-560S |
| L66 | IND CHOKE 68UH 10% | 23642-560S |
| L67 | PRINTED COIL | |
| L68 | PRINTED COIL | |
| L69 | PRINTED COIL | |
| L70 | RES. LEAD LENGTH | |
| L72 | PRINTED COIL | |
| L73 | PRINTED COIL | |
| L74 | RF COIL 10UH 4T | 44290-805W |
| L75 | RF COIL 10UH 4T | 44290-805W |
| L76 | RF COIL 10UH 4T | 44290-805W |
| L77 | RES. LEAD LENGTH | |
| L79 | PRINTED COIL | |
| L80 | PRINTED COIL | |
| L83 | PRINTED COIL | |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| L84 | PRINTED COIL | |
| L90 | 6-HOLE FERRITE, 2.4UH INDUCTOR | 44290-790U |
| L91 | RES. LEAD LENGTH | |
| L92 | RES. LEAD LENGTH | |
| PLCM | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCN | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCP | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCR | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLCT | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLDF | CONN ASSY | 43129-537Y |
| R1 | RES MF 360R 1/4W 2% | 24773-262T |
| R2 | RES MF 1K0 1/4W 2% | 24773-273A |
| R3 | RES MF 470R 1/4W 2% | 24773-265M |
| R4 | RES MF 3K0 1/4W 2% | 24773-284J |
| R5 | RES MF 3K0 1/4W 2% | 24773-284J |
| R6 | RES MF 75R 1/4W 2% | 24773-246Y |
| R7 | RES MF 1K5 1/4W 2% | 24773-277U |
| R8 | RES CC 150R 1/8W 5% | 24331-990D |
| R9 | RES CC 150R 1/8W 5% | 24331-990D |
| R10 | RES CHIP 16R 5% | 24681-043E |
| R11 | RES CHIP 16R 5% | 24681-043E |
| R12 | RES MF 51R 1/4W 2% | 24773-242Z |
| R13 | RES MF 51R 1/4W 2% | 24773-242Z |
| R14 | RES MF 6K8 1/4W 2% | 24773-293D |
| R15 | RES MF 6K8 1/4W 2% | 24773-293D |
| R16 | RES MF 200R 1/4W 2% | 24773-256S |
| R17 | RES MF 820R 1/4W 2% | 24773-271B |
| R18 | RES MF 75R 1/4W 2% | 24773-246Y |
| R19 | RES MF 2K4 1/4W 2% | 24773-282N |
| R20 | RES MF 820R 1/4W 2% | 24773-271B |
| R21 | RES MF 820R 1/4W 2% | 24773-271B |
| R22 | RES MF 3K9 1/4W 2% | 24773-287V |
| R23 | RES MF 360R 1/4W 2% | 24773-262T |
| R24 | RES MF 470R 1/4W 2% | 24773-265M |
| R25 | RES MF 5K6 1/4W 2% | 24773-291S |
| R26 | RES MF 300R 1/4W 2% | 24773-260W |
| R27 | RES MF 300R 1/4W 2% | 24773-260W |
| R28 | RES MF 6K8 1/4W 2% | 24773-293D |
| R29 | RES MF 270R 1/4W 2% | 24773-259T |
| R30 | RES MF 240R 1/4W 2% | 24773-258D |
| R31 | RES MF 10K 1/4W 2% | 24773-297M |
| R32 | RES MF 240R 1/4W 2% | 24773-258D |
| R33 | RES MF 1K0 1/4W 2% | 24773-273A |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| R34 | RES MF 470R 1/4W 2% | 24773-265M |
| R35 | RES MF 1K5 1/4W 2% | 24773-277U |
| R36 | RES MF 470R 1/4W 2% | 24773-265M |
| R37 | RES MF 1K0 1/4W 2% | 24773-273A |
| R38 | RES MF 470R 1/4W 2% | 24773-265M |
| R39 | RES MF 1K0 1/4W 2% | 24773-273A |
| R40 | RES MF 470R 1/4W 2% | 24773-265M |
| R41 | RES MF 240R 1/4W 2% | 24773-258D |
| R42 | RES MF 470R 1/4W 2% | 24773-265M |
| R43 | RES MF 680R 1/4W 2% | 24773-269K |
| R44 | RES MF 680R 1/4W 2% | 24773-269K |
| R45 | RES MF 680R 1/4W 2% | 24773-269K |
| R46 | RES MF 680R 1/4W 2% | 24773-269K |
| R47 | RES MF 1K0 1/4W 2% | 24773-273A |
| R48 | RES MF 470R 1/4W 2% | 24773-265M |
| R50 | RES MF 470R 1/4W 2% | 24773-265M |
| R51 | RES MF 1K0 1/4W 2% | 24773-273A |
| R52 | RES MF 470R 1/4W 2% | 24773-265M |
| R53 | RES MF 1K0 1/4W 2% | 24773-273A |
| R54 | RES MF 1K5 1/4W 2% | 24773-277U |
| R55 | RES MF 470R 1/4W 2% | 24773-265M |
| R56 | RES MF 470R 1/4W 2% | 24773-265M |
| R57 | RES MF 470R 1/4W 2% | 24773-265M |
| R58 | RES MF 10K 1/4W 2% | 24773-297M |
| R59 | RES MF 10K 1/4W 2% | 24773-297M |
| R60 | RES MF 10K 1/4W 2% | 24773-297M |
| R61 | RES MF 10K 1/4W 2% | 24773-297M |
| R62 | RES MF 2K7 1/4W 2% | 24773-283L |
| R63 | RES MF 680R 1/4W 2% | 24773-269K |
| R64 | RES CHIP 51R 5% | 24681-045Y |
| R65 | RES CHIP 51R 5% | 24681-045Y |
| R66 | RES MF 18R 1/4W 2% | 24773-231P |
| R67 | RES MF 470R 1/4W 2% | 24773-265M |
| R68 | RES MF 1K0 1/4W 2% | 24773-273A |
| R69 | RES CC 51R 1/8W 5% | 24331-989P |
| R70 | RES MF 3K9 1/4W 2% | 24773-287V |
| R71 | RES MF 680R 1/4W 2% | 24773-269K |
| R72 | RES CHIP 16R 5% | 24681-043E |
| R73 | RES CC 100R 1/8W 5% | 24331-997B |
| R74 | RES CHIP 10R 5% | 24681-042H |
| R75 | RES CC 100R 1/8W 5% | 24331-997B |
| R76 | RES MF 2K4 1/4W 2% | 24773-282N |
| R77 | RES MF 2K4 1/4W 2% | 24773-282N |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AC13 | - FILTER & FREQ DOUBLER BOARD | (Contd.) |
| R78 | RES MF 2K4 1/4W 2% | 24773-282N |
| R79 | RES MF 2K4 1/4W 2% | 24773-282N |
| R80 | RES MF 47K 1/4W 2% | 24773-313H |
| R81 | RES MF 36R 1/4W 2% | 24773-238A |
| R82 | RES MF 2K4 1/4W 2% | 24773-282N |
| R83 | RES MF 2K4 1/4W 2% | 24773-282N |
| R84 | RES CC 82R 1/8W 5% | 24331-996R |
| R85 | RES MF 3K9 1/4W 2% | 24773-287V |
| R86 | RES MF 680R 1/4W 2% | 24773-269K |
| R87 | RES CHIP 16R 5% | 24681-043E |
| R88 | RES CC 68R 1/8W 5% | 24331-979F |
| R89 | RES MF 240R 1/4W 2% | 24773-258D |
| R90 | RES CC 150R 1/8W 5% | 24331-990D |
| R91 | RES MF 470R 1/4W 2% | 24773-265M |
| R92 | RES MF 1K0 1/4W 2% | 24773-273A |
| R93 | RES MF 470R 1/4W 2% | 24773-265M |
| R99 | RES MF 3K9 1/4W 2% | 24773-287V |
| R100 | RES MF 3K9 1/4W 2% | 24773-287V |
| R101 | RES MF 3K9 1/4W 2% | 24773-287V |
| R102 | RES MF 3K9 1/4W 2% | 24773-287V |
| R103 | RES MF 3K9 1/4W 2% | 24773-287V |
| R104 | RES MF 1K0 1/4W 2% | 24773-273A |
| R105 | RES MF 470R 1/4W 2% | 24773-265M |
| R106 | RES MF 3K9 1/4W 2% | 24773-287V |
| R107 | RES MF 3K9 1/4W 2% | 24773-287V |
| R108 | RES MF 470R 1/4W 2% | 24773-265M |
| R109 | RES MF 470R 1/4W 2% | 24773-265M |
| R110 | RES CHIP 10R 5% | 24681-042H |
| R111 | RES CC 100R 1/8W 5% | 24331-997B |
| R112 | RES CC 100R 1/8W 5% | 24331-997B |
| SKCS | CON RF SMB MALE 50 PCB STR | 23444-334Y |
| TR1 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR2 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR3 | TRANS NPN SIL 2N2369 15V | 28452-197H |
| TR4 | TRANS NPN SIL BFR96 15V | 28452-171Y |
| TR5 | TRANS NPN SIL BFR90 15V | 28452-167U |
| TR6 | TRANS NPN SIL BFR91 12V | 28451-696U |

| Circuit Ref | Description | | Part Number |
|---|---|---|---|
| Unit AD1 | - DISPLAY BOARD | | Issue 2 |
| 22. | When ordering,prefix circuit reference with AD1 | | |
| | Complete unit | | 44828-441K |
| C1 | CAP TANT 4.7UF 35V 20% BEAD | | 26486-219P |
| C2 | CAP TANT 4.7UF 35V 20% BEAD | | 26486-219P |
| C3 | CAP PETP 0.022UF 250V 10% | | 26582-204X |
| C4 | CAP TANT 4.7UF 35V 20% BEAD | | 26486-219P |
| D1 | DIODE ZENER BZY88C10 10V 5% | | 28371-843E |
| IC1 | ICD BUFF 7407 HEX O/C | | 28469-703X |
| IC2 | ICD BUFF 7407 HEX O/C | | 28469-703X |
| IC3 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC4 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC5 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC6 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC7 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC8 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC9 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC10 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC11 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC12 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC13 | ICD NOR 74LS02 QUAD 2INP | | 28466-214Y |
| IC14 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC15 | ICD DECOD 4028 BCD-DEC | ! | 28465-013B |
| IC16 | ICD DECOD 4028 BCD-DEC | ! | 28465-013B |
| IC17 | ICD DECOD 4028 BCD-DEC | ! | 28465-013B |
| IC18 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC19 | ICD MONO 4047 ASTABLE MULTI | ! | 28468-307C |
| IC20 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC21 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC22 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC23 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |
| IC24 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC25 | ICD DEC/DMX 4555 DUAL 2-4 | ! | 28465-017H |
| IC26 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC27 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC28 | ICD DRIV 4054 LCD | ! | 28469-398Z |
| IC29 | ICD DECOD 4056 BCD-7SEG LCD | ! | 28469-401B |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AD1 | - DISPLAY BOARD | (Contd.) |
| IC30 | ICD DECOD 4056 BCD-7SEG LCD ! | 28469-401B |
| IC31 | ICD DECOD 4056 BCD-7SEG LCD ! | 28469-401B |
| IC32 | ICD DRIV 4054 LCD ! | 28469-398Z |
| IC33 | ICD DRIV 4054 LCD ! | 28469-398Z |
| PLAL | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES NET 6K8 5% 15DIL | 24681-514C |
| R2 | RES MF 220K 1/4W 2% | 24773-329T |
| X1 | LCD 4575-363-060 | 44990-361M |
| X2 | LCD 4576-363-060 | 44990-362C |
| X3 | LCD 4577-363-060 | 44990-363R |
| Unit AD2 | - MOTHER BOARD | Issue 1 |
| 23. When ordering, prefix circuit reference with AD2 | | |
| | Complete unit | 44828-442A |
| C1 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C2 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| IC1 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC2 | ICD BUFF 7406 HEX O/C I | 28469-158A |
| IC3 | ICD NOR 74128 QUAD 2INP BUF | 28466-224S |
| PLL | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLW | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLX | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLY | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLZ | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLAA | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLAB | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLAD | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLAE | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLAF | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLDM | CON PART PCB POST SQUARE PIN | 23435-188V |
| SKAH | CON EDGE FEM 13 FXD .15 2S | 23435-145E |

| Circuit Ref | Description | | Part Number |
|---|---|---|---|
| Unit AD3 | - MOD. OSC. AND FM CONTROL BOARD | | Issue 7 |
| 24. | When ordering, prefix circuit reference with AD3 | | |
| | Complete unit | | 44828-443Z |
| C1 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C2 | CAP PS 0.01UF 63V 1% | | 26515-002C |
| C3 | CAP PS 0.01UF 63V 1% | | 26515-002C |
| C4 | CAP PETP 0.68UF 100V 10% | | 26582-216E |
| C5 | CAP PETP 0.15UF 100V 10% | | 26582-212K |
| C6 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C7 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C8 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C9 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C10 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C11 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C12 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C13 | CAP CER 56PF 63V 2% PLATE | | 26343-474J |
| C15 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C16 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C17 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C18 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C19 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C20 | CAP CER 0.01UF 100V 20% DISC | | 26383-055L |
| C21 | CAP TANT .47UF 35V 20% BEAD | | 26486-207L |
| C22 | CAP TANT .47UF 35V 20% BEAD | | 26486-207L |
| C23 | CAP TANT .47UF 35V 20% BEAD | | 26486-207L |
| D1 | DIODE SIL 1N4148 100V JUNC | | 28336-676J |
| D2 | DIODE SIL 1N4148 100V JUNC | | 28336-676J |
| D3 | DIODE SIL 1N4148 100V JUNC | | 28336-676J |
| D4 | DIODE ZENER BZY88C7V5 7.5V 5% | | 28371-603H |
| D5 | DIODE SIL 1N4148 100V JUNC | | 28336-676J |
| IC1 | ICA AMP TL072CP DUAL FET I/P | | 28461-348Z |
| IC2 | ICA MUX 4053 TRIP 3INP | ! | 28469-714H |
| IC3 | ICA MUX 4052 DUAL 4INP | ! | 28469-713Z |
| IC4 | ICA MUX 4053 TRIP 3INP | ! | 28469-714H |
| IC5 | ICD FF D 74LS273 OCT +EDG TR | | 28462-615U |
| IC6 | ICA MUX 4053 TRIP 3INP | ! | 28469-714H |

| Circuit Ref | Description | | Part Number |
|---|---|---|---|
| Unit AD3 | - MOD. OSC. AND FM CONTROL BOARD (Contd.) | | |
| IC7 | ICA MUX 4053 TRIP 3INP | ! | 28469-714H |
| IC8 | ICA AMP TL072CP DUAL FET I/P | | 28461-348Z |
| IC9 | ICA AMP TL072CP DUAL FET I/P | | 28461-348Z |
| IC10 | ICA AMP TL072CP DUAL FET I/P | | 28461-348Z |
| IC11 | ICA DAC AD7524JN 8BIT | ! | 28469-400R |
| IC12 | ICA AMP TL071CP FET I/P DIL8 | | 28461-347A |
| IC13 | ICD INV 74LS04 HEX | | 28469-171L |
| IC14 | ICD DEC/DMX 74LS138 3-8 | | 28465-027F |
| IC15 | ICA DAC AD7522LN 10BIT MOS | ! | 28469-402K |
| IC16 | ICA AMP TL071CP FET I/P DIL8 | | 28461-347A |
| IC17 | ICA DAC AD7524JN 8BIT | ! | 28469-400R |
| IC18 | ICA AMP TL071CP FET I/P DIL8 | | 28461-347A |
| IC19 | ICA AMP NE5534AH H-PRF TO99 | | 28461-329V |
| R1 | RES MF 130R 1/4W 2% | | 24773-252J |
| R2 | RV THERM 10K 20% GLASS RA14 | | 25683-389E |
| R3 | RES MF 2K56 1/4W 0.5% 25PPM | | 24753-564F |
| R4 | RES MF 5K05 1/4W 0.5% 50PPM | | 24753-667G |
| R5 | RES MF 15K83 1/4W 0.5% | | 24753-560Y |
| R6 | RES MF 39K7 1/4W 0.5% | | 24753-561N |
| R7 | RES MF 53K0 1/4W 0.5% | | 24753-562L |
| R8 | RES MF 5K05 1/4W 0.5% 50PPM | | 24753-667G |
| R9 | RES MF 15K83 1/4W 0.5% | | 24753-560Y |
| R10 | RES MF 39K7 1/4W 0.5% | | 24753-561N |
| R11 | RES MF 53K0 1/4W 0.5% | | 24753-562L |
| R12 | RES MF 2K56 1/4W 0.5% 25PPM | | 24753-564F |
| R13 | RES MF 100K 1/4W 2% | | 24773-321L |
| R14 | RES MF 470R 1/4W 2% | | 24773-265M |
| R15 | RES MF 4K7 1/4W 2% | | 24773-289W |
| R16 | RV CERM 2K LIN .3W 10% FLAT | | 25748-505T |
| R17 | RES MF 10K 1/4W 2% | | 24773-297M |
| R18 | RES MF 390R 1/4W 2% | | 24773-263P |
| R19 | RES MF 620R 1/4W 2% | | 24773-268B |
| R20 | RES MF 100R 1/4W 2% | | 24773-249J |
| R21 | RES MF 1M0 1/4W 2% | | 24773-346E |
| R22 | RES MF 1M0 1/4W 2% | | 24773-346E |
| R23 | RES MF 12K 1/4W 2% | | 24773-299R |
| R24 | RES MF 3K0 1/4W 2% | | 24773-284J |
| R25 | RES MF 270K 1/4W 2% | | 24773-331D |
| R26 | RES MF 270K 1/4W 2% | | 24773-331D |
| R27 | RES MF 5K6 1/4W 2% | | 24773-291S |
| R28 | RES MF 1K0 1/4W 2% | | 24773-273A |
| R29 | RES MF 1K0 1/4W 2% | | 24773-273A |
| R30 | RV CERM 500R LIN .3W 10% FLAT | | 25748-503W |
| R31 | RES MF 6K8 1/4W 2% | | 24773-293D |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AD3 | - MOD. OSC. AND FM CONTROL BOARD | (Contd.) |
| R32 | RES MF 12K 1/4W 2% | 24773-299R |
| R33 | RV CERM 500R LIN .3W 10% FLAT | 25748-503W |
| R34 | RES MF 1KO 1/4W 2% | 24773-273A |
| R35 | RES NET 10K 5% 8DIL DIL | 24681-511P |
| R36 | RES MF 390R 1/4W 2% | 24773-263P |
| R37 | RES MF 10K 1/4W 2% | 24773-297M |
| R38 | RES MF 240R 1/4W 2% | 24773-258D |
| R39 | RES MF 39K 1/4W 2% | 24773-311A |
| R40 | RES MF 470R 1/4W 2% | 24773-265M |
| R41 | RES MF 240R 1/4W 2% | 24773-258D |
| R42 | RES MF 10K 1/4W 2% | 24773-297M |
| R43 | RES MF 10K 1/4W 2% | 24773-297M |
| R44 | RES MF 10K 1/4W 2% | 24773-297M |
| R45 | RES MF 10K 1/4W 2% | 24773-297M |
| R46 | RES MF 10K 1/4W 2% | 24773-297M |
| R47 | RES MF 10K 1/4W 2% | 24773-297M |
| R48 | RES MF 10K 1/4W 2% | 24773-297M |
| R49 | RES MF 10K 1/4W 2% | 24773-297M |
| TR1 | TRANS FET J310 25V | 28459-028E |
| Unit AD4 | - KEYBOARD | Issue 3 |
| 25. | When ordering, prefix circuit reference with AD4 | |
| | Complete unit | 44828-444H |
| C1 | CAP CER 0.01UF 40V 20%+ PLATE | 26387-253M |
| C2 | CAP CER 0.01UF 40V 20%+ PLATE | 26387-253M |
| C3 | CAP CER 0.01UF 40V 20%+ PLATE | 26387-253M |
| C4 | CAP CER 0.01UF 40V 20%+ PLATE | 26387-253M |
| C5 | CAP CER 0.01UF 40V 20%+ PLATE | 26387-253M |
| D1 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D2 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D3 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D4 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D5 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D8 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| D10 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| D11 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| D12 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| D13 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AD4 | - KEYBOARD | (Contd.) |
| D14 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| D15 | DIODE LED CQY87V180P 2.4V YEL | 28624-121Z |
| IC1 | ICD DEC/DMX 74LS138 3-8 | 28465-027F |
| IC2 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC3 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC4 | ICD FF D 74LS273 OCT +EDG TR | 28462-615U |
| IC5 | ICD BUFF 74LS244 OCT 3ST | 28469-182T |
| R1 | RES MF 330R 1/4W 2% | 24773-261D |
| R2 | RES NET 100R 5% 8SINGLE DIL | 24681-515R |
| R3 | RES MF 100K 1/4W 2% | 24773-321L |
| R4 | RES MF 100K 1/4W 2% | 24773-321L |
| R5 | RES NET 10K 5% 8DIL DIL | 24681-511P |
| SA | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SB | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SC | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SD | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SE | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SF | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SH | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SJ | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SK | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SL | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SM | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SP | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SR | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SS | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| ST | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SU | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SV | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SW | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SX | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SY | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SZ | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAA | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAB | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAC | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAD | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAE | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAF | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAH | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAJ | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AD4 | - KEYBOARD | (Contd.) |
| SAK | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAL | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| SAM | SW PUSH BUTTON SPCO 24V 10MA | 23465-411B |
| TR1 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| TR2 | TRANS NPN SIL ZTX109CL 20V | 28452-771P |
| Unit AE1 | - POWER SUPPLY BOARD | Issue 4 |
| 26. | When ordering, prefix circuit reference with AE1 | |
| | Complete unit | 44828-446U |
| C1 | CAP ELEC 15000UF 16V -10+30% | 26422-320S |
| C2 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C3 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C4 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C5 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C6 | CAP ELEC 4700UF 40V -10+30% | 26422-321W |
| C7 | CAP ELEC 2200UF 40V 20%+ | 26415-831P |
| C8 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C9 | CAP ELEC 4.7UF 63V 20%+ | 26415-801M |
| C10 | CAP ELEC 220UF 63V 20%+ | 26415-820J |
| C11 | CAP ELEC 22UF 25V 20%+ | 26415-805K |
| C12 | CAP ELEC 4.7UF 63V 20%+ | 26415-801M |
| D1 | DIODE BRIDGE 2KBB20R 200V 1.9A | 28359-189D |
| D2 | DIODE BRIDGE 2KBB20R 200V 1.9A | 28359-189D |
| D3 | DIODE BRIDGE 2KBB20R 200V 1.9A | 28359-189D |
| D4 | DIODE RECT 1N4004 400V | 28357-028K |
| D5 | DIODE RECT 1N4004 400V | 28357-028K |
| D6 | DIODE RECT 1N4004 400V | 28357-028K |
| D7 | DIODE RECT 1N4004 400V | 28357-028K |
| D8 | DIODE RECT 1N4004 400V | 28357-028K |
| IC1 | ICA VREG- LM337T PROG 1A5 | 28461-727Z |
| IC2 | ICA VREG+ LM317T PROG 1A5 | 28461-726A |
| PLB | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLC | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLD | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLE | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLH | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLJ | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLK | CON PART PCB POST SQUARE PIN | 23435-188V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AE1 | - POWER SUPPLY BOARD | (Contd.) |
| R1 | RES MF 220R 1/4W 2% | 24773-257W |
| R2 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| R3 | RES MF 680R 1/4W 2% | 24773-269K |
| R4 | RES MF 220R 1/4W 2% | 24773-257W |
| R5 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| R6 | RES MF 2K7 1/4W 2% | 24773-283L |
| R7 | RES MF 220R 1/4W 2% | 24773-257W |
| R8 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| R9 | RES MF 2K7 1/4W 2% | 24773-283L |
| R10 | RES MF 220R 1/4W 2% | 24773-257W |
| R11 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| R12 | RES MF 4K3 1/4W 2% | 24773-288S |
| Unit AM0 | - BASIC MODULE (44990-380J) | Issue 7 |

27. When ordering, prefix circuit reference with AM0

| | | |
|---|---|---|
| D1 | DIODE BRIDGE BY260 200V 12A | 28359-190S |
| FS1 | FUSE T/LAG .50A 20X5MM | 23411-056X |
| FS2 | FUSE T/LAG .50A 20X5MM | 23411-056X |
| FS3 | FUSE T/LAG 1.0A 20X5MM | 23411-058C |
| FS4 | FUSE T/LAG 1.0A 20X5MM | 23411-058C |
| IC1 | ICA VREG+ LM350K PROG 3A TO3 | 28461-722C |
| IC2 | ICA VREG+ LM317K PROG 1A5 TO3 | 28461-728H |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AM0 | - BASIC MODULE | (Contd.) |
| PLA | CON PWR MALE 3 FXD RF FILTER | 23423-150L |
| PLAU | CONN ASSY PLAU-PLAW | 43129-655T |
| PLAV | CONN ASSY PLAV-PLAX | 43129-656P |
| PLAY | CONN ASSY PLAY-PLAZ | 43129-657X |
| PLBA | CONN ASSY PLBA-SKBB | 43129-658M |
| SAP | SW TOG 2P2W LEVER MAINS | 23462-249Z |
| SAR | SW SLIDE DPCO PANEL MTG | 23467-161W |
| SAS | SW SLIDE DPCO PANEL MTG | 23467-161W |
| SKB | CONN ASSY SKB | 43129-694C |
| SKC | CONN ASSY SKC | 43129-695R |
| SKE | CONN ASSY SKE-SKM | 43129-643M |
| SKH | CONN ASSY SKH-SKW | 43129-645J |
| SKJ | CONN ASSY SKJ | 43129-646F |
| SKK | CONN ASSY SKK | 43129-647G |
| SKL | CONN ASSY SKL | 43129-651V |
| SKV | CONN ASSY SKV-SKAE | 43129-649S |
| SKX | CONN ASSY SKX | 43129-650G |
| SKY | CONN ASSY SKY-SKAK | 43129-691P |
| SKZ | CONN ASSY SKZ | 43129-644L |
| SKAA | CONN ASSY SKAA | 43129-652S |
| SKAB | CONN ASSY SKAB-SKAL | 43129-653W |
| SKAF | CONN ASSY SKAF | 43129-648V |
| SKAN | CON RF BNC FEM 50 BKHD | 23443-446H |
| SKAP | CONN ASS SKAP-PLAR | 43129-654D |
| T1 | MAINS TRANSFORMER | 43490-074Z |
| R1 | RES MF 220R 1/4W 2% | 24773-257W |
| R2 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| R3 | RES MF 680R 1/4W 2% | 24773-269K |
| R4 | RES MF 220R 1/4W 2% | 24773-257W |
| R5 | RV CERM 50R LIN .5W 10% HORZ | 25711-634N |
| X1 | FUSE HOLDER PANEL MOUNTED | 23416-192R |
| X2 | COVER FOR FUSE HOLDER | 23416-198E |
| X3 | COVER MAINS FILTER | 37590-150P |
| X4 | COVER (MAINS SW) | 37590-298U |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AT0 | - 10DB STEP ATTENUATOR ASSEMBLY | Issue 3 |
| 28. When ordering, prefix circuit reference with AT0 | | |
| | Complete unit | 44990-353W |
| C1 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C2 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| C3 | CAP CER .001UF 500V 20%+ L/T | 26373-714F |
| RLA | SOLENOID ASSY | 44990-370Z |
| RLB | SOLENOID ASSY | 44990-370Z |
| RLC | SOLENOID ASSY | 44990-370Z |
| RLD | SOLENOID ASSY | 44990-370Z |
| RLE | SOLENOID ASSY | 44990-370Z |
| SKN | CONN ASSY SKN | 43129-689X |
| SKP | CONN ASSY SKP | 43129-690T |
| SKAZ | CON RF SMC MALE 50 BKHD SOLDER | 23444-382T |
| SKBA | CON RF SMA FEM 50 PANEL SOLDER | 23444-503H |
| Unit AT1 | - ATTENUATOR BOARD | Issue 3 |
| 29. When ordering, prefix circuit reference with AT1 | | |
| | Complete unit | 44828-448N |
| C1 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| C2 | CAP CER .039UF 50V 20% CHIP | 26386-493F |
| D1 | DIODE HOT CARR HP5082-2811 | 28349-008U |
| D2 | DIODE HOT CARR HP5082-2811 | 28349-008U |
| L1 | COIL ASSY | 44290-750K |
| R1 | RES CHIP 53R3 1% | 24681-023S |
| R2 | RES CHIP 790R 1% | 24681-033C |
| R3 | RES CHIP 53R3 1% | 24681-023S |
| R4 | RES CHIP 53R3 1% | 24681-023S |
| R5 | RES CHIP 790R 1% | 24681-033C |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AT1 | - ATTENUATOR BOARD | (Contd.) |
| R6 | RES CHIP 53R3 1% | 24681-023S |
| R7 | RES CHIP 53R3 1% | 24681-023S |
| R8 | RES CHIP 790R 1% | 24681-033C |
| R9 | RES CHIP 53R3 1% | 24681-023S |
| R10 | RES CHIP 61R1 1% | 24681-024W |
| R11 | RES CHIP 247R 1% | 24681-030P |
| R12 | RES CHIP 61R1 1% | 24681-024W |
| R13 | RES CHIP 96R3 2% | 24681-027P |
| R14 | RES CHIP 71R2 1% | 24681-025D |
| R15 | RES CHIP 96R3 2% | 24681-027P |
| R16 | RES CHIP 470R 5% | 24681-046N |
| R17 | RES CHIP 470R 5% | 24681-046N |
| R18 | RES CHIP 51R 5% | 24681-045Y |
| R19 | RES CHIP 51R 5% | 24681-045Y |
| R20 | RES CC 150R 1/8W 5% | 24331-990D |
| RLF | SW REED 1NO REED | 23486-452P |
| SA | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SB | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SC | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SD | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SE | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SF | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SH | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SJ | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SK | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| SL | SW MICRO 1P2W PLUNGR OPER | 23483-144G |
| X2 | RELAY TUBE | 35902-731V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AT2 | - ATTENUATOR CONTROL | Issue 3 |
| 30. | When ordering, prefix circuit reference with AT2 | |
| | Complete unit | 44828-445E |
| C1 | CAP CER 47PF 63V 5% PLATE | 26343-473L |
| C2 | CAP TANT .47UF 35V 20% BEAD | 26486-207L |
| C3 | CAP CER 1.8PF 63V .5PF PLATE | 26343-456C |
| C4 | CAP CER 0.01UF 100V 20% DISC | 26383-055L |
| C5 | CAP TANT 4.7UF 35V 20% BEAD | 26486-219P |
| D1 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D2 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D3 | DIODE ZENER BZY88C10 10V 5% | 28371-843E |
| D4 | DIODE ZENER BZY88C24 24V | 28373-271J |
| D5 | DIODE ZENER BZY88C24 24V | 28373-271J |
| D6 | DIODE ZENER BZY88C24 24V | 28373-271J |
| D7 | DIODE ZENER BZY88C24 24V | 28373-271J |
| D8 | DIODE ZENER BZY88C24 24V | 28373-271J |
| D9 | DIODE SIL 1N4148 100V JUNC | 28336-676J |
| D10 | DIODE LED LLL37 2.4V YELLOW | 28624-106T |
| D11 | DIODE RECT 1N4004 400V | 28357-028K |
| IC1 | ICA AMP CA3130S GP MOS TO99 ! | 28461-323Y |
| IC2 | ICA COMP LM311N DIL8 | 28461-695U |
| IC3 | ICD NOR 74LS02 QUAD 2INP | 28466-214Y |
| IC4 | ICD MONO 74LS122 RETR | 28468-310C |
| PLM | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLN | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLP | CON PART PCB POST SQUARE PIN | 23435-188V |
| PLV | CON PART PCB POST SQUARE PIN | 23435-188V |
| R1 | RES MF 100K 1/4W 2% | 24773-321L |
| R2 | RES MF 47K 1/4W 2% | 24773-313H |
| R3 | RES MF 100K 1/4W 2% | 24773-321L |
| R4 | RES MF 10K 1/4W 2% | 24773-297M |
| R5 | RES MF 10K 1/4W 2% | 24773-297M |
| R6 | RES MF 24K 1/4W 2% | 24773-306B |
| R7 | RES MF 1K3 1/4W 2% | 24773-276E |
| R8 | RES MF 3K9 1/4W 2% | 24773-287V |
| R9 | RES MF 10K 1/4W 2% | 24773-297M |
| R10 | RES MF 10K 1/4W 2% | 24773-297M |
| R11 | RES MF 510R 1/4W 2% | 24773-266C |
| R12 | RES MF 47K 1/4W 2% | 24773-313H |
| R13 | RES MF 10K 1/4W 2% | 24773-297M |
| R14 | RES MF 24K 1/4W 2% | 24773-306B |
| R15 | RES MF 3K9 1/4W 2% | 24773-287V |

| Circuit Ref | Description | Part Number |
|---|---|---|
| Unit AT2 | - ATTENUATOR CONTROL | (Contd.) |
| R16 | RES MF 200R 1/4W 2% | 24773-256S |
| R17 | RES MF 10K 1/4W 2% | 24773-297M |
| TR1 | TRANS PNP SIL BC308 25V | 28433-455R |
| TR2 | TRANS NPN SIL BFY51 60V | 28455-827T |
| TR3 | TRANS PNP SIL 2N2905 40V | 28434-879X |

MECHANICAL COMPONENTS

31. Order without prefix.

Fig. 1

| Item | Description | Part no. |
|---|---|---|
| 1 | Bottom outer cover | 35903-279B |
| 2 | Front panel switch caps, marked:- | |
| | STORE | 37590-323X |
| | RECALL | 37590-324M |
| | MOD OSC | 37590-371U |
| | MOD ALC | 37590-372Y |
| | INCREMENT | 37590-373N |
| | CARRIER FREQ | 37590-374L |
| | FM | 37590-375J |
| | AM | 37590-376F |
| | RF LEVEL | 37590-377G |
| | 7 | 37590-334H |
| | 4 | 37590-331K |
| | 1 | 37590-328K |
| | 0 | 37590-325C |
| | 8 | 37590-335E |
| | 5 | 37590-332A |
| | 2 | 37590-329A |
| | . | 37590-326R |
| | 9 | 37590-336U |
| | 6 | 37590-333Z |
| | 3 | 37590-330B |
| | - | 37590-327B |
| | MHz/V | 37590-390X |
| | kHz/mV | 37590-391M |
| | Hz/µV | 37590-392C |
| | %/dB | 37590-393R |
| | INT/EXT | 37590-394B |
| | TOTAL | 37590-395K |
| | UP | 37590-396A |
| | ON/OFF | 37590-397Z |
| | RETURN | 37590-398H |
| | DOWN | 37590-399E |
| | SECOND FUNCT | 37590-400B |
| 3 | Front panel assy. | 35903-115A |
| 4 | Carrier frequency bezel | 37590-408N |
| | Modulation and r.f. level bezel | 37590-409L |
| 5 | Front trim panel | 34900-477G |
| 6 | Front trim infill | 35902-371Z |
| 7 | Left-hand side trim infill | 35902-384V |
| 8 | Left-hand side frame assy. | 35903-314M |
| 9 | Top outer cover | 35903-278R |
| 10 | Back foot | 37590-514L |
| | Stud | 37590-223C |

Chapter 7

# SERVICING DIAGRAMS

## CONTENTS

Para.
1 Circuit notes
1 Component values
3 Symbols

| Fig. | Unit | Title | Page |
|---|---|---|---|
| 1 | 2018/2019 | Frequency synthesis and signal processing, simplified block diagram ... ... ... | 3 |
| 2a | AE1 | Component layout ... ... ... ... ... | 4 |
| 2 | AM0 | Power supplies (includes board AE1) ... ... | 5/6 |
| 3 | AM0 | Basic module interconnections ... ... ... | 7/8 |
| 4 | AM0 | Control and power supply lines ... ... ... | 9/10 |
| 5 | AA/B0 | RF box 1 interconnections .. ... ... ... | 11 |
| 6a | AA1 | Component layout ... ... ... ... ... | 12 |
| 6 | AA1 | LSD loop ... ... ... ... ... ... | 13 |
| 7a | AA2 | Component layout ... ... ... ... ... | 14 |
| 7 | AA2 | Microprocessor system ... ... ... ... | 15 |
| 8a | AA3 | Component layout ... ... ... ... ... | 16 |
| 8 | AA3 | Frequency standard ... ... ... ... | 17 |
| 9a | AB1 | Component layout ... ... ... ... ... | 18 |
| 9 | AB1 | Output v.r.d. ... ... ... ... ... | 19 |
| 10a | AB2 | Component layout ... ... ... ... ... | 20 |
| 10 | AB2 | Divide by 2 chain and f.m. drive ... ... ... | 21 |
| 11a | AB3 | Component layout ... ... ... ... ... | 22 |
| 11 | AB3 | RF oscillators board ... ... ... ... | 23 |
| 12a | AB4 | Component layout ... ... ... ... ... | 24 |
| 12 | AB4 | Output phase detector ... ... ... ... | 25 |
| 13a | AB5 | Component layout ... ... ... ... ... | 26 |
| 13 | AB5 | Voltage controlled crystal oscillator loop ... | 27/28 |
| 14 | AC0 | RF box 2 interconnections .. ... ... ... | 29 |
| 15a | AC2 | Component layout ... ... ... ... ... | 30 |
| 15 | AC2 | BFO system ... ... ... ... ... | 31/32 |
| 16 | AC3 | Filter board (for component layout see Fig. 19a) ... | 33 |
| 17a | AC4 | Component layout ... ... ... ... ... | 34 |
| 17 | AC4 | Output amplifier ... ... ... ... ... | 35 |
| 18a | AC5 | Component layout ... ... ... ... ... | 36 |
| 18 | AC5 | Amplitude modulator ... ... ... ... | 37 |
| 19a | AC13 | Component layout (AC3 & AC13) ... ... ... | 38 |
| 19 | AC13 | Filter and frequency doubler (2019 only) ... ... | 39 |
| 20a | AD1 | Component layout ... ... ... ... ... | 40 |
| 20 | AD1 | Display board (sheet 1) ... ... ... ... | 41/42 |
| 21 | AD1 | Display board (sheet 2) ... ... ... ... | 43 |
| 22a | AD2 | Component layout ... ... ... ... ... | 44 |
| 22 | AD2 | Motherboard ... ... ... ... ... | 45 |
| 23a | AD3 | Component layout ... ... ... ... ... | 46 |
| 23 | AD3 | Modulation oscillator and f.m. control ... ... | 47 |

| Fig. | | Title | Page |
|---|---|---|---|
| 24a | AD4 | Component layout ... ... ... ... ... | 48 |
| 24 | AD4 | Keyboard ... ... ... ... ... ... | 49/50 |
| | AE1 | Power supply board (part of AM0, Fig. 2) | |
| 25 | AT0 | 10 dB step attenuator ... ... ... ... | 51 |
| 26a | AT2 | Component layout ... ... ... ... ... | 52 |
| 26 | AT2 | Attenuator control .. ... ... ... ... | 53 |
| 27a | AG0 | Component layout ... ... ... ... ... | 54 |
| 27 | AG0 | GPIB adapter module . ... ... ... ... | 55/56 |


## CIRCUIT NOTES

1. Component values

Resistors : Code letter R = ohms, k = kilohms ($10^3$), M = megohms ($10^6$).

Capacitors : Code letter m = millifarads ($10^{-3}$), µ = microfarads ($10^{-6}$), n = nanofarads ($10^{-9}$), p = picofarads ($10^{-12}$).

Inductors : Code letter H = henrys, m = millihenrys ($10^{-3}$), µ = microhenrys ($10^{-6}$), n = nanohenrys ($10^{-9}$).

† SIC : value selected during test, nominal value shown.

2. Components are marked normally with two, three or four figures according to the accuracy limit ±10%, ±1% or ±0.1%. The code letter used indicates the multiplier and replaces the decimal point. Because a marking 4m7 could be interpreted as milliohms, millifarads or millihenrys all values are placed near to its related symbol.

3. Symbols

Symbols are based on the provisions of BS 3939 with the following additions :

edge connector

ferrite bead

warning, see page (iv), notes and cautions

Beryllia : health hazard, see page (iv), notes and cautions

unit identification number

P printed component

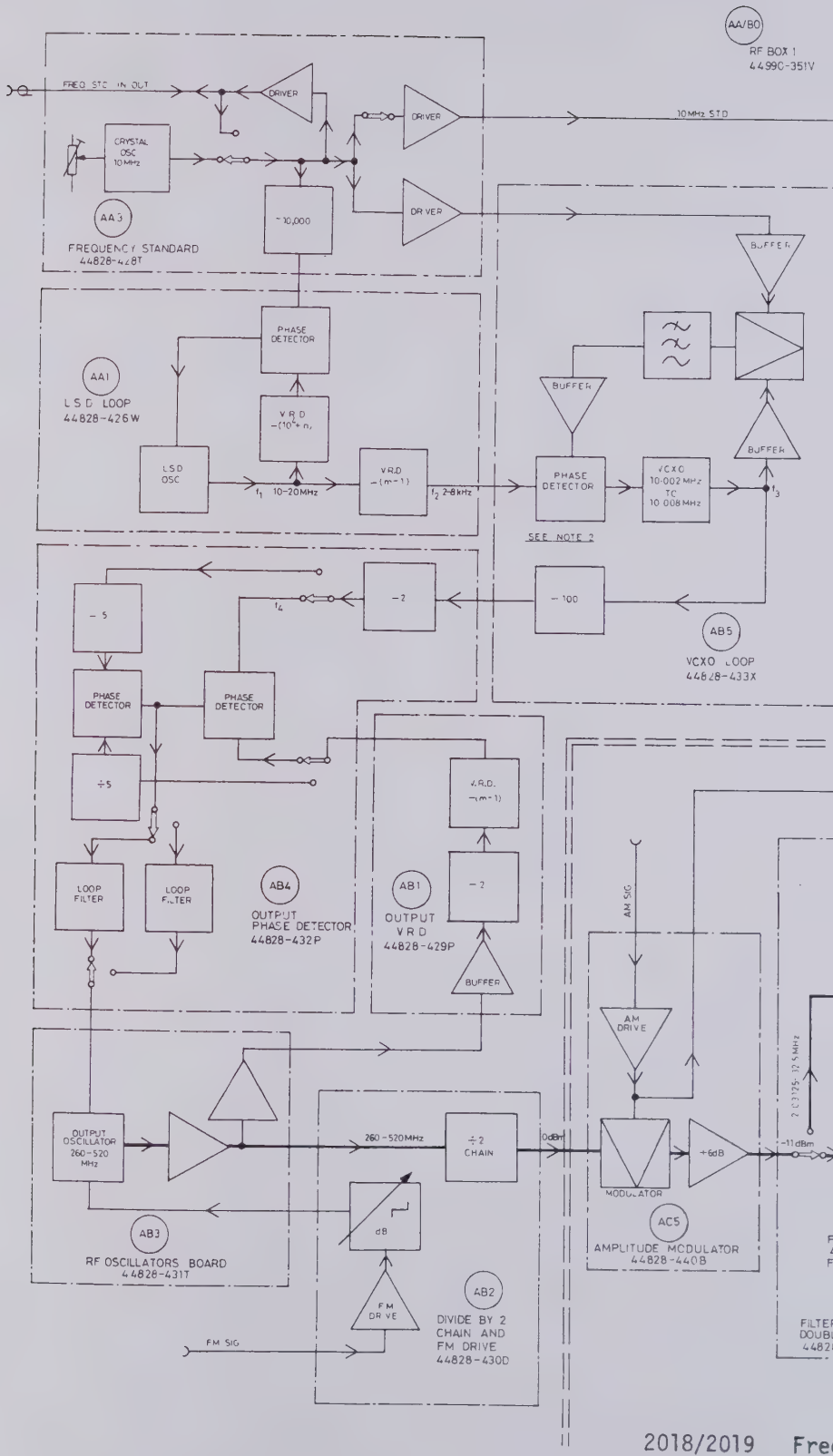
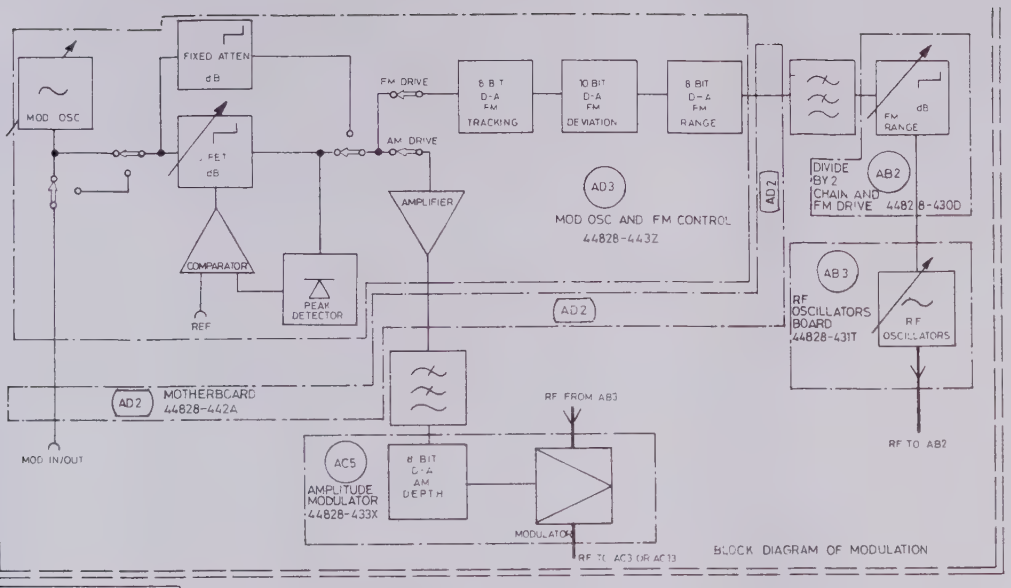

AA/BO
RF BOX 1
44990-351V
FREQ STD IN OUT
DRIVER
DRIVER
10 MHz STD
CRYSTAL OSC 10 MHz
DRIVER
÷10,000
AA3
FREQUENCY STANDARD
44828-428T
BUFFER
PHASE DETECTOR
AA1
L S D LOOP
44828-426W
V R D
−(10^n+n)
BUFFER
BUFFER
LSD OSC
f1 10-20MHz
V.R.D −(m−1)
f2 2-8kHz
PHASE DETECTOR
VCXO 10·002 MHz TC 10·008 MHz
f3
SEE NOTE 2
÷ 5
f4
÷ 2
÷ 100
AB5
VCXO LOOP
44828-433X
÷ 5
PHASE DETECTOR
PHASE DETECTOR
÷5
V.R.D. −(m−1)
LOOP FILTER
LOOP FILTER
AB4
OUTPUT PHASE DETECTOR
44828-432P
AB1
OUTPUT V R D
44828-429P
÷ 2
BUFFER
AM SIG
AM DRIVE
OUTPUT OSCILLATOR 260-520 MHz
260-520MHz
÷2 CHAIN
0dBm
+6dB
-11dBm
MODULATOR
dB
AB3
RF OSCILLATORS BOARD
44828-431T
AC5
AMPLITUDE MODULATOR
44828-440B
FM DRIVE
AB2
DIVIDE BY 2 CHAIN AND FM DRIVE
44828-430D
FM SIG
2018/2019

Fig. 1

Sep. 81




NOTES

1 THE SWITCHES SHOWN ARE ELECTRONICALLY CONTROLLED THE PROGRAMMED CONTROL LINES ARE NOT SHOWN

2 TO DETERMINE THE FREQUENCY THE FOLLOWING APPLIES

LET $f_0 = m \times 10^5 + n \times 10$

WHERE m IS 2600 TO 5200

n IS 0000 TO 9999

$$f_1 = (10^4 + n)10^3$$

$$f_2 = \frac{(10^4 + n)10^3}{m-1}$$

$$f_3 = 10^7 + \frac{(10^4 + n)10^3}{m-1}$$

$$f_4 = \frac{10^7 + \frac{(10^4 + n)10^3}{m-1}}{200}$$

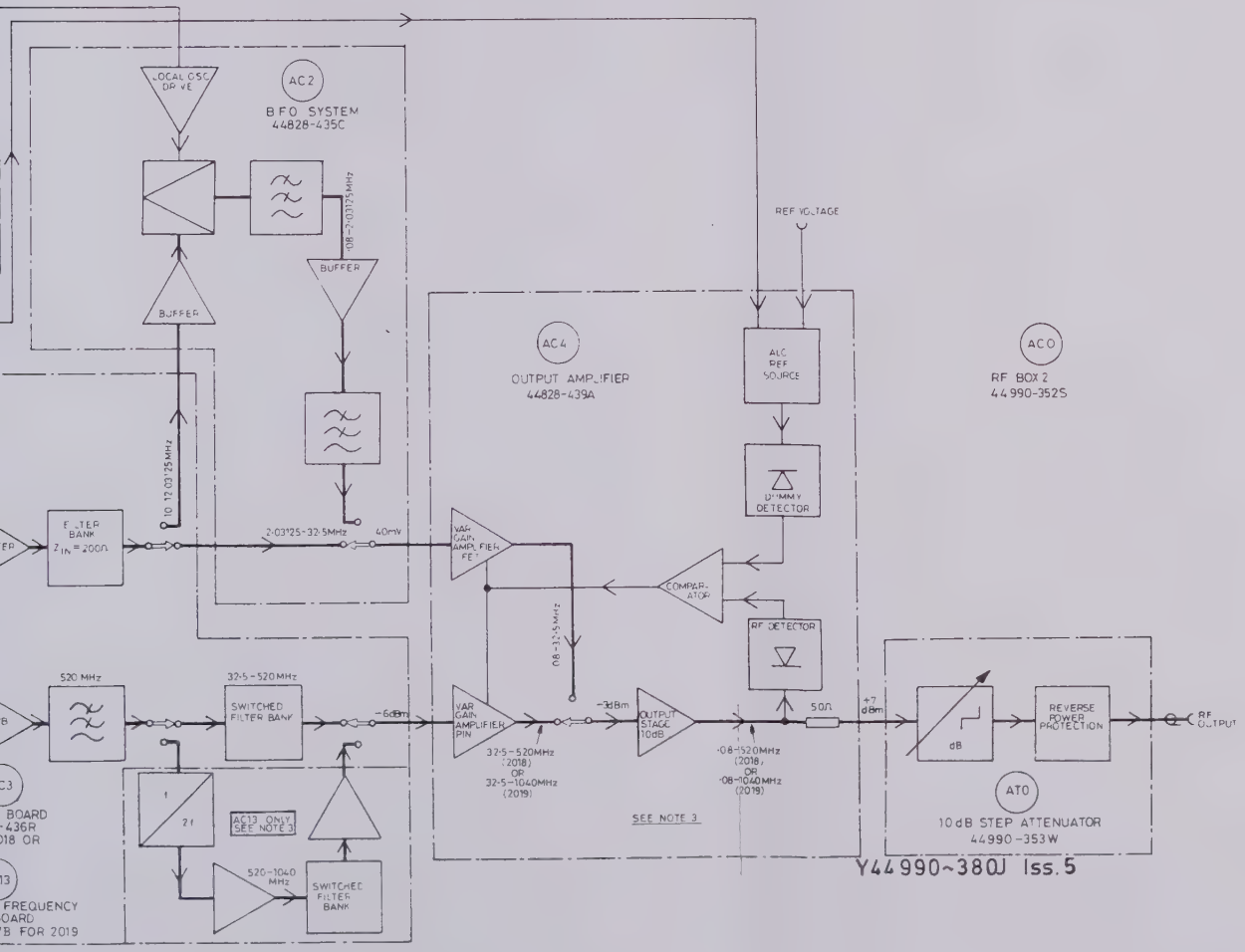
$$f_0 = \frac{2(m-1)}{200}\left(10^7 + \frac{(10^4 + n)10^3}{m-1}\right)$$

$$f_0 = 10^5(m-1) + 10(10^4 + n)$$

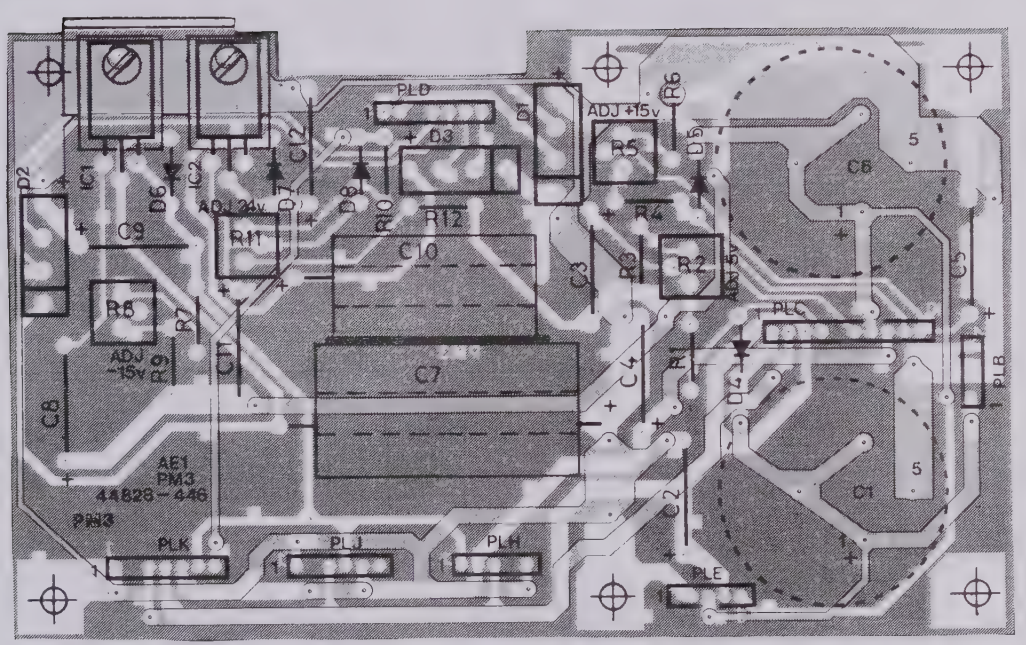
$$f_0 = m \times 10^5 + n \times 10$$

3 2018 = BASIC MODULE AMO + ASSY KIT AS0
COVERS FREQ 0·8-520MHz
THE AC3 FILTER BOARD IS USED

2019 = BASIC MODULE AMO + ASSY KIT AS10
COVERS FREQ 0·8-1040MHz
THE AC13 FILTER AND FREQ DOUBLER BOARD IS USED




ency synthesis and signal processing,
plified block diagram




Component layout, AE1

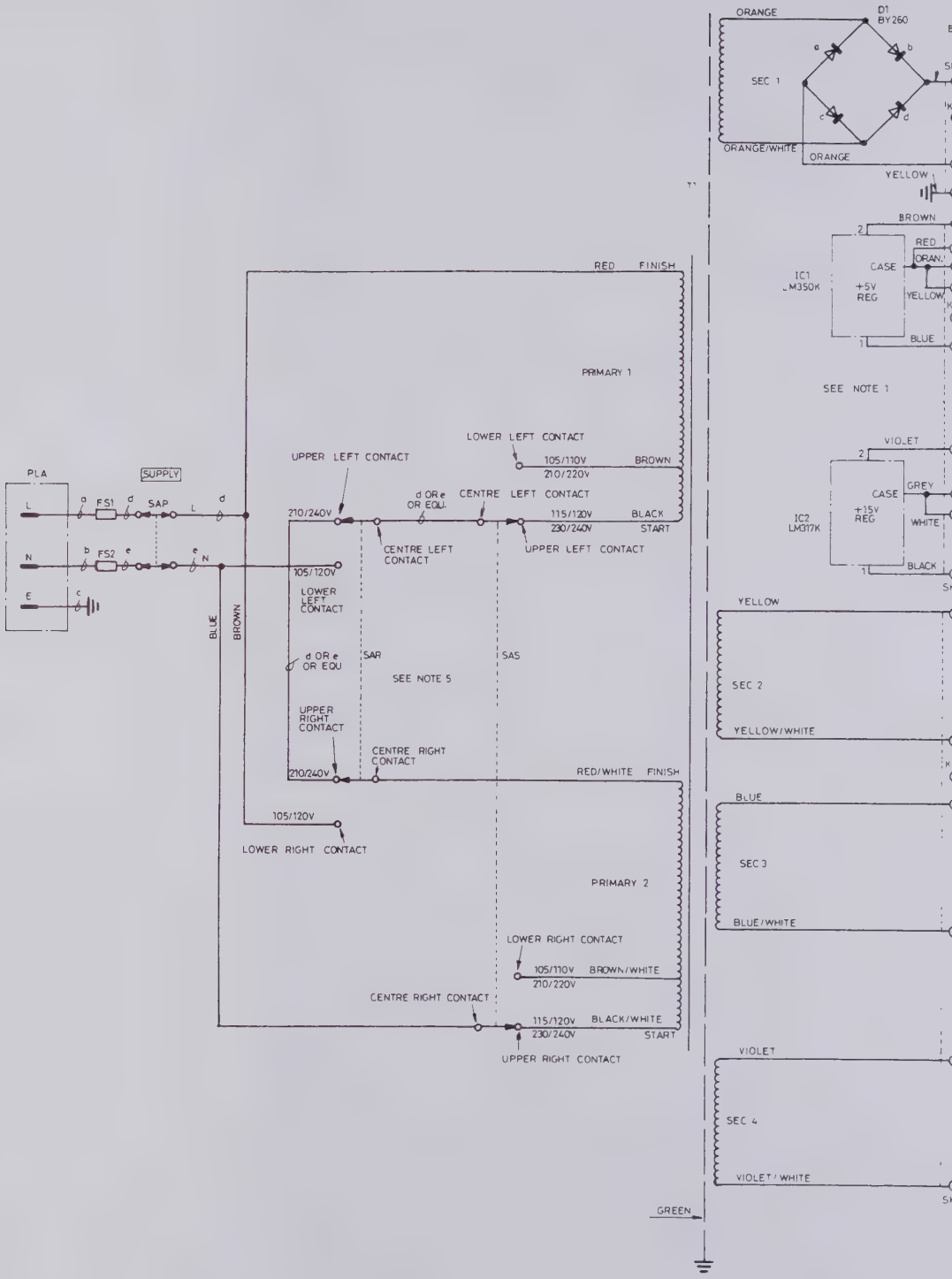
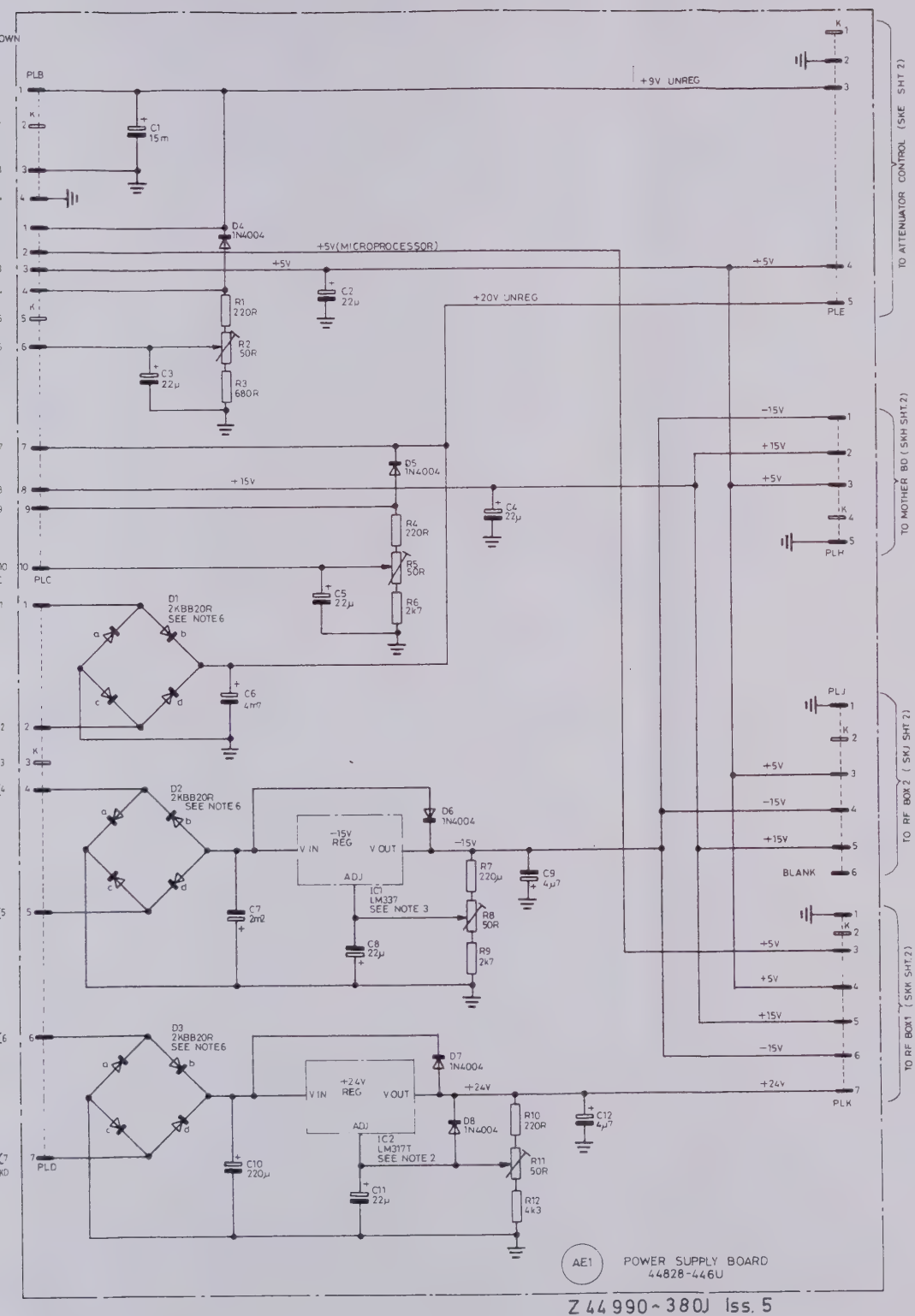



Fig. 2

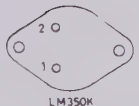
Sep. 81

Power su



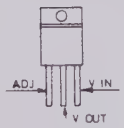

Z 44 990-380J Iss. 5

1



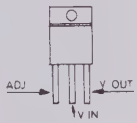

LM350K
LM317K
VIEW ON PIN SIDE

2




LM317T
VIEW FROM TOP

3




LM337T
VIEW FROM TOP

4. WIRES MARKED AS FOLLOWS

a ARE 15410-227T
b ARE 15410-222G
c ARE 15420-276U
d ARE 15410-187W
e ARE 15410-182J

UNMARKED WIRES ARE TO M15410-207 S.S.

5 LOOKING FROM FRONT OF INST SWITCH SAR IS TO THE RIGHT OF SAS NOTES OF LEFT AND RIGHT CONTACTS REFER TO THE VIEW FROM THE INST FRONT

6

2KBB20R

upplies, AM0 (includes board AE1)

AM0

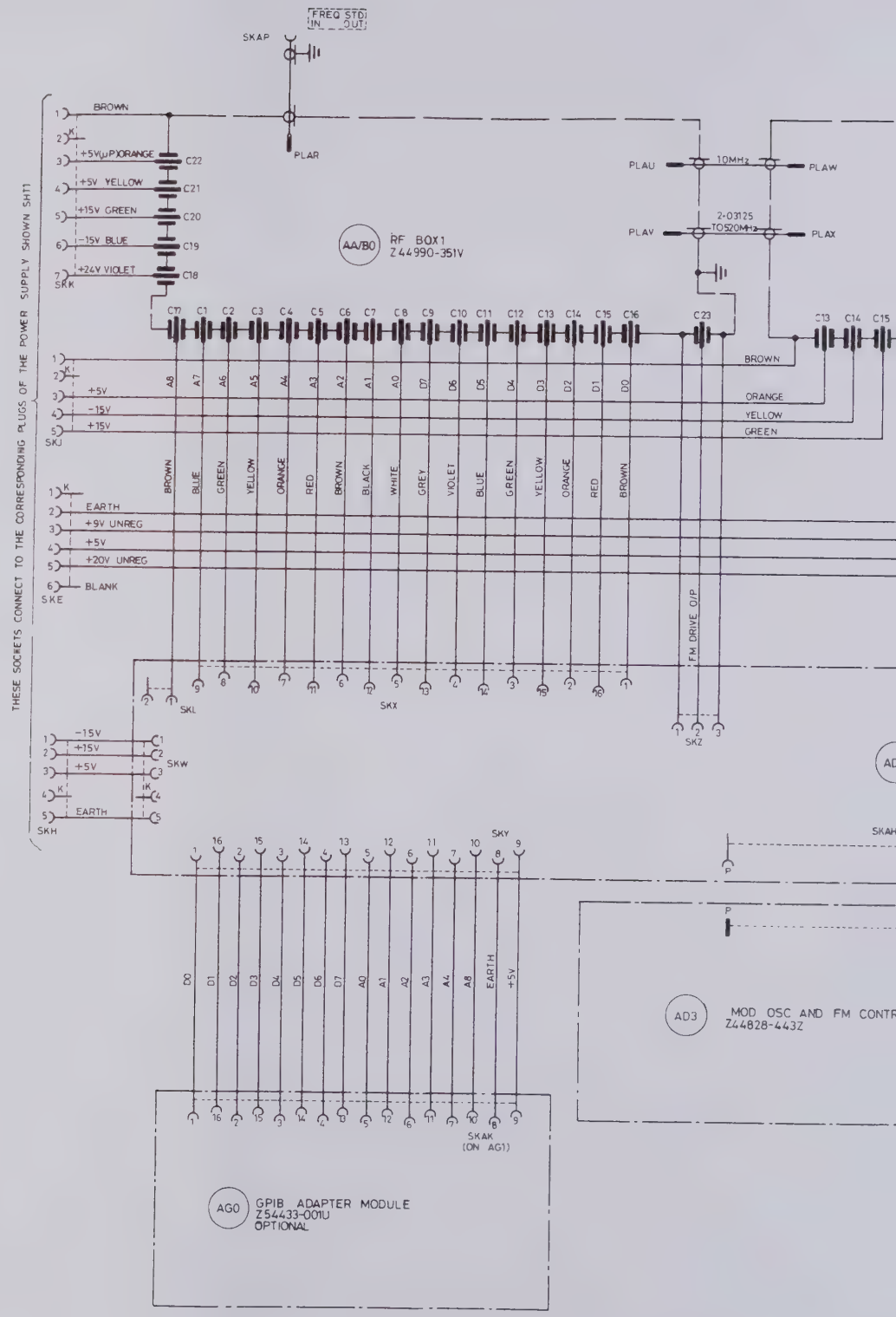
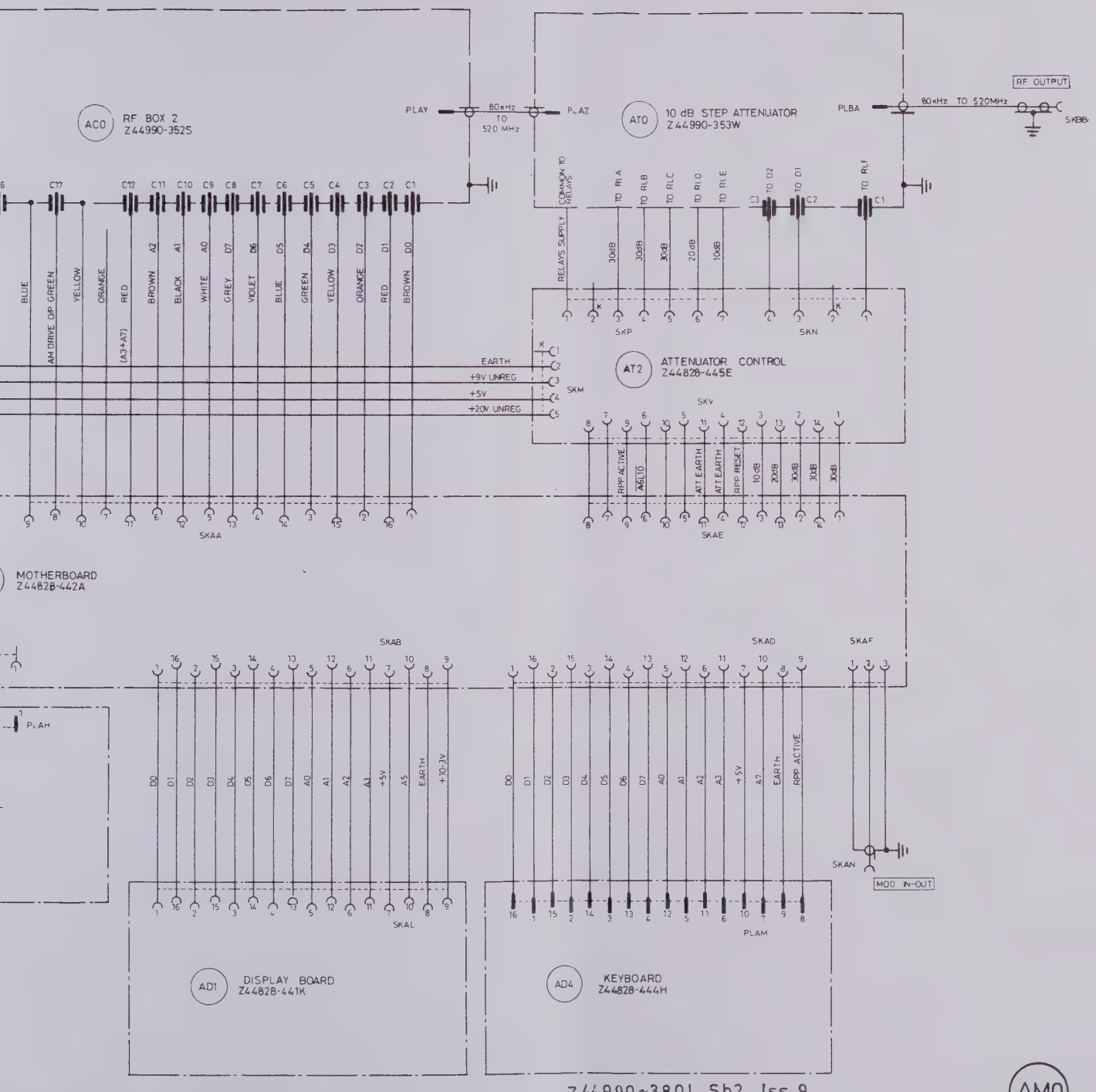

FREQ STD
IN OUT
SKAP
PLAR
BROWN
+5V(μP) ORANGE
+5V YELLOW
+15V GREEN
-15V BLUE
+24V VIOLET
C22
C21
C20
C19
C18
SKK
AA/B0
RF BOX1
Z44990-351V
PLAU
10MHz
PLAW
PLAV
2·03125
TO 20MHz
PLAX
C17 C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C23
C13 C14 C15
BROWN
ORANGE
YELLOW
GREEN
A8 A7 A6 A5 A4 A3 A2 A1 A0 D7 D6 D5 D4 D3 D2 D1 D0
+5V
-15V
+15V
SKJ
BROWN BLUE GREEN YELLOW ORANGE RED BROWN BLACK WHITE GREY VIOLET BLUE GREEN YELLOW ORANGE RED BROWN
EARTH
+9V UNREG
+5V
+20V UNREG
BLANK
SKE
F.M. DRIVE O/P
SKL
SKX
SKZ
THESE SOCKETS CONNECT TO THE CORRESPONDING PLUGS OF THE POWER SUPPLY SHOWN SHT1
-15V
+15V
+5V
EARTH
SKW
SKH
SKY
SKAH
D0 D1 D2 D3 D4 D5 D6 D7 A0 A1 A2 A3 A4 A8 EARTH +5V
SKAK
(ON AG1)
AD3
MOD OSC AND FM CONTR
Z44828-443Z
AG0
GPIB ADAPTER MODULE
Z54433-001U
OPTIONAL

Fig. 3

Sep. 81

1 MATING PLUGS AND SOCKETS CARRY CORRESPONDING IDENTITY i.e PLAR PLUGS INTO SKAR THEREFORE IN SOME CASES ONLY ONE OF THE PAIR MAY BE SHOWN
2 THE 1·04 GHz VERSION 52018-301K (A010) IS IDENTICAL EXCEPT FOR RF BOX 2




Z44990-380J Sh2. Iss.9.

ic module interconnections, AM0

AM0

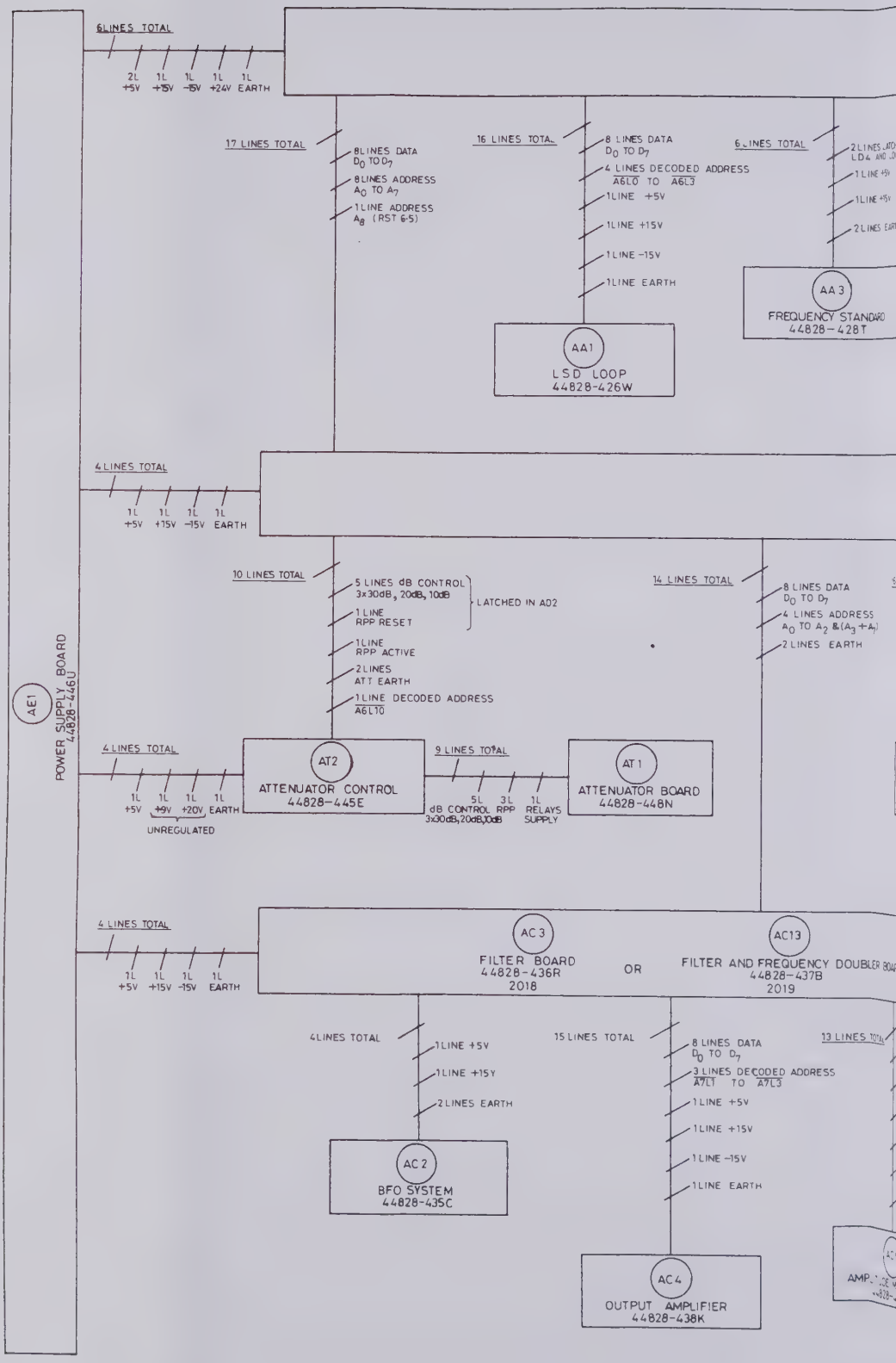
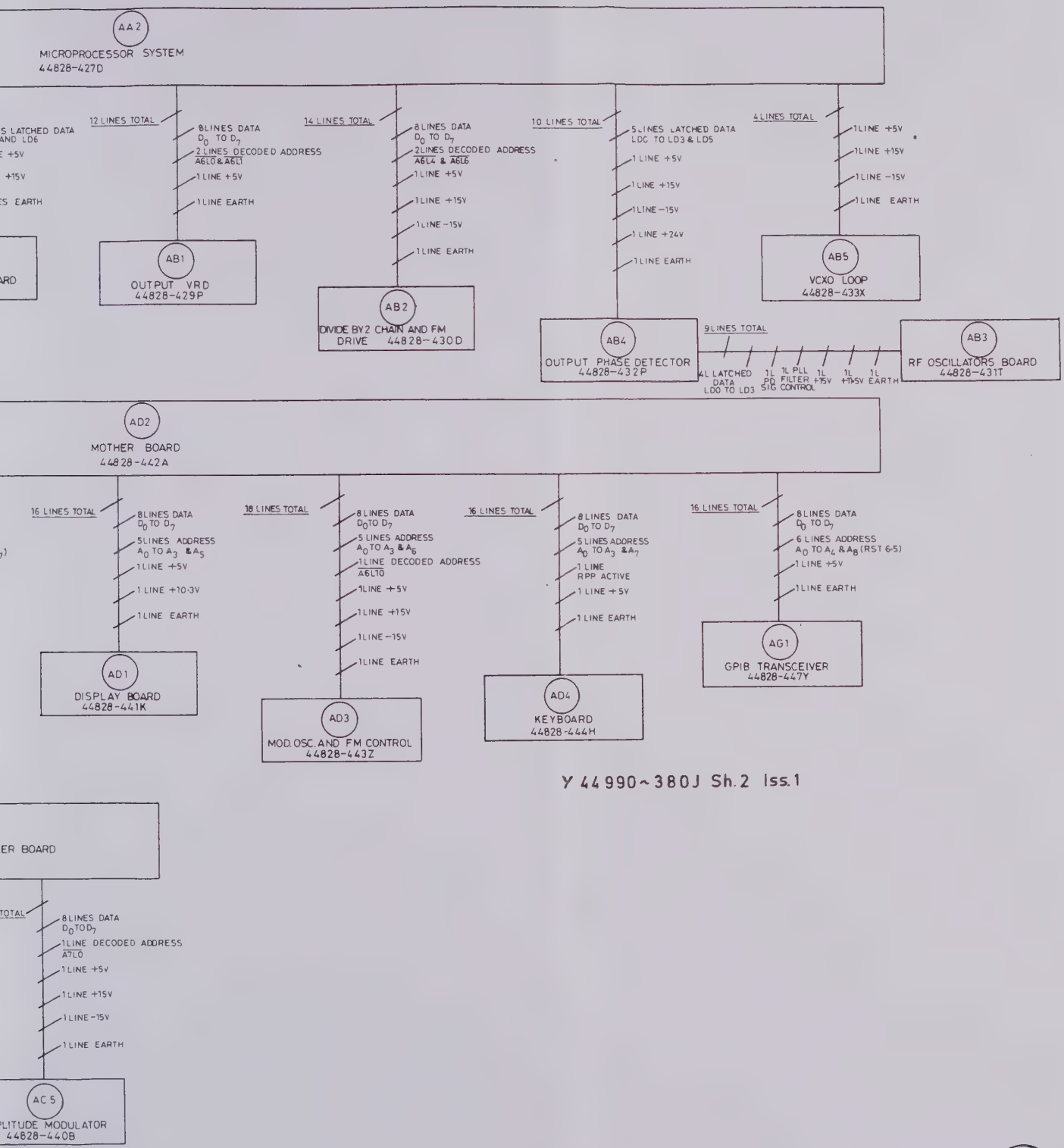

6 LINES TOTAL
2L +5V
1L +15V
1L −15V
1L +24V
1L EARTH
17 LINES TOTAL
8 LINES DATA D0 TO D7
8 LINES ADDRESS A0 TO A7
1 LINE ADDRESS A8 (RST 6·5)
16 LINES TOTAL
8 LINES DATA D0 TO D7
4 LINES DECODED ADDRESS A6L0 TO A6L3
1 LINE +5V
1 LINE +15V
1 LINE −15V
1 LINE EARTH
6 LINES TOTAL
2 LINES
1 LINE +5V
1 LINE +5V
2 LINES EARTH
AA3
FREQUENCY STANDARD
44828-428T
AA1
LSD LOOP
44828-426W
4 LINES TOTAL
1L +5V
1L +15V
1L −15V
1L EARTH
10 LINES TOTAL
5 LINES dB CONTROL 3x30dB, 20dB, 10dB
LATCHED IN A02
1 LINE RPP RESET
1 LINE RPP ACTIVE
2 LINES ATT EARTH
1 LINE DECODED ADDRESS A6L10
14 LINES TOTAL
8 LINES DATA D0 TO D7
4 LINES ADDRESS A0 TO A2 &(A3 +A7)
2 LINES EARTH
AE1
POWER SUPPLY BOARD
44828-446U
4 LINES TOTAL
1L +5V
1L +9V
1L +20V
1L EARTH
UNREGULATED
AT2
ATTENUATOR CONTROL
44828-445E
9 LINES TOTAL
5L dB CONTROL 3x30dB,20dB,10dB
3L RPP
1L RELAYS SUPPLY
AT1
ATTENUATOR BOARD
44828-448N
4 LINES TOTAL
1L +5V
1L +15V
1L −15V
1L EARTH
AC3
FILTER BOARD
44828-436R
2018
OR
AC13
FILTER AND FREQUENCY DOUBLER BOARD
44828-437B
2019
4 LINES TOTAL
1 LINE +5V
1 LINE +15V
2 LINES EARTH
AC2
BFO SYSTEM
44828-435C
15 LINES TOTAL
8 LINES DATA D0 TO D7
3 LINES DECODED ADDRESS A7L1 TO A7L3
1 LINE +5V
1 LINE +15V
1 LINE −15V
1 LINE EARTH
13 LINES TOTAL
AC4
OUTPUT AMPLIFIER
44828-438K

Fig. 4

Sep. 81




Y 44990~380J Sh.2 Iss.1




ontrol and power supply lines, AM0

AM0

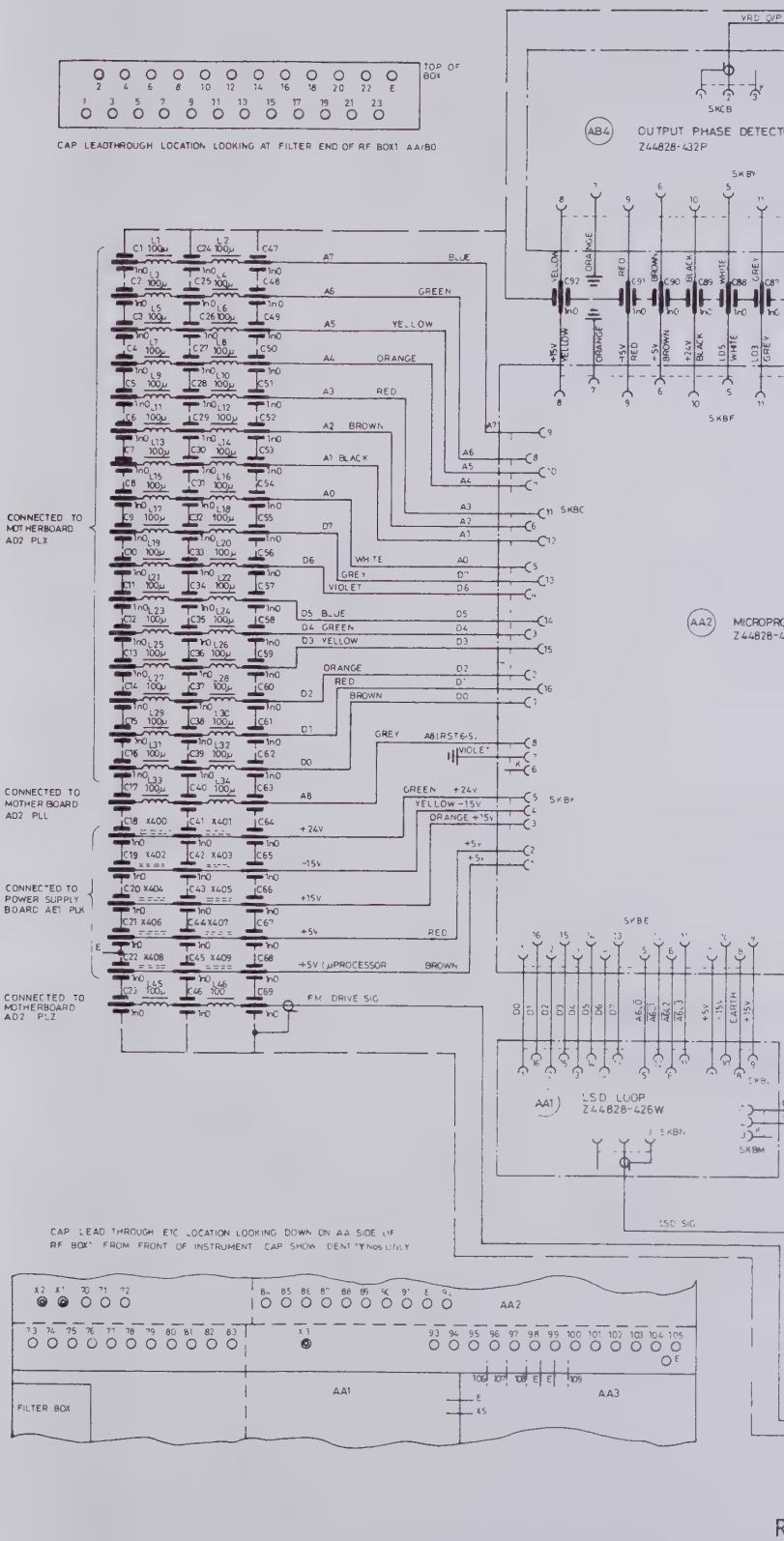
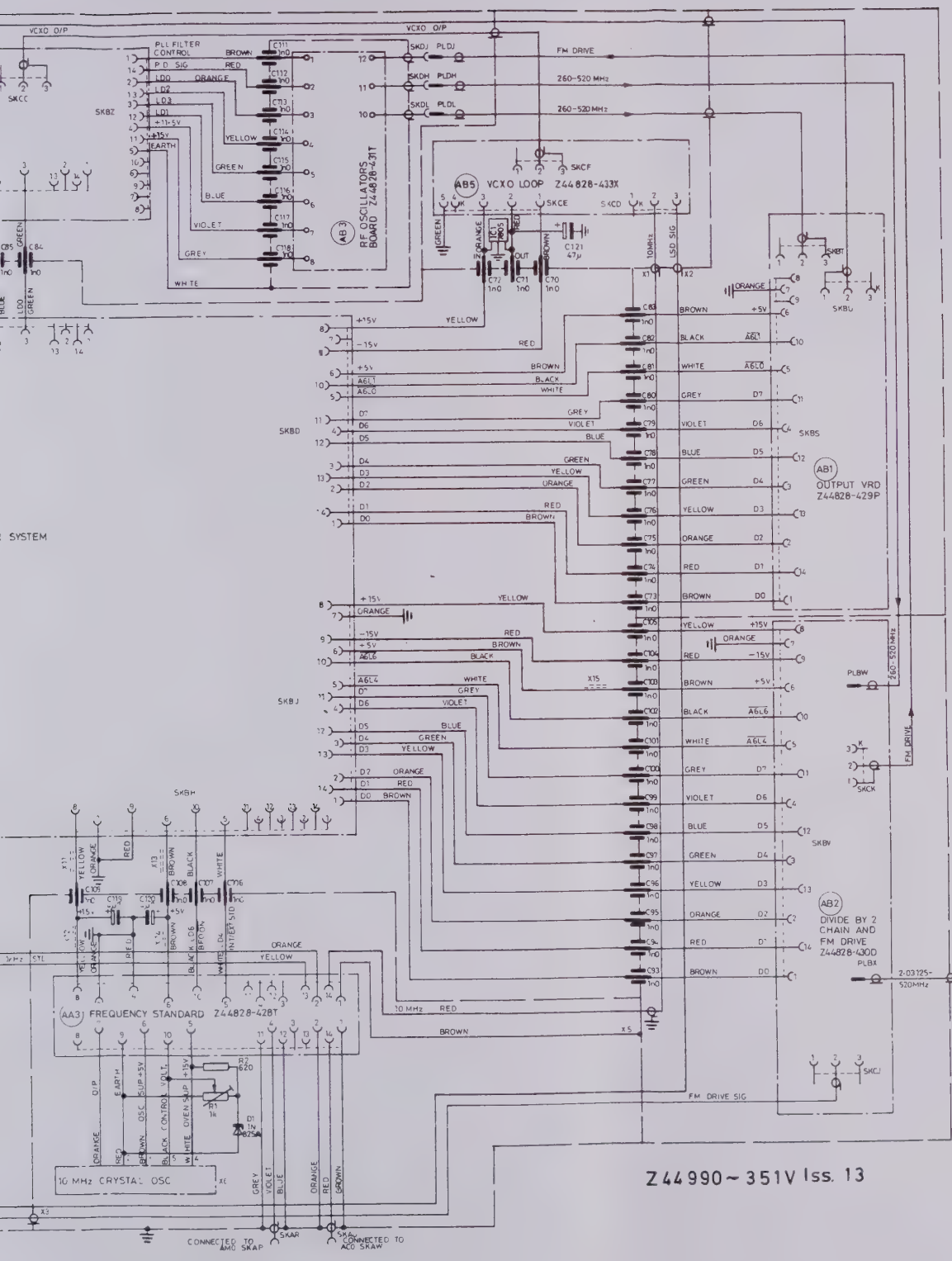

TOP OF BOX
CAP LEADTHROUGH LOCATION LOOKING AT FILTER END OF RF BOX1 AA/B0
AB4 OUTPUT PHASE DETECT
Z44828-432P
SKBF
SKBC
SKBE
SKBA
SKBM
SKBH
AA2 MICROPR
Z44828-4
AA1 LSD LOOP
Z44828-426W
CONNECTED TO MOTHERBOARD AD2 PLX
CONNECTED TO MOTHER BOARD AD2 PLL
CONNECTED TO POWER SUPPLY BOARD AE1 PLX
CONNECTED TO MOTHERBOARD AD2 PLZ
A7 BLUE
A6 GREEN
A5 YELLOW
A4 ORANGE
A3 RED
A2 BROWN
A1 BLACK
A0
D7
D6 WHITE
GREY
VIOLET
D5 BLUE
D4 GREEN
D3 YELLOW
ORANGE
D2
RED
BROWN
D1
GREY
D0
A8
+24V
-15V
+5V
+15V
+5V
+5V (μPROCESSOR
FM DRIVE SIG
LSD SIG
CAP LEAD THROUGH ETC LOCATION LOOKING DOWN ON AA SIDE OF RF BOX FROM FRONT OF INSTRUMENT CAP SHOW IDENTITY NOS ONLY
AA2
AA1
AA3
FILTER BOX

Fig. 5

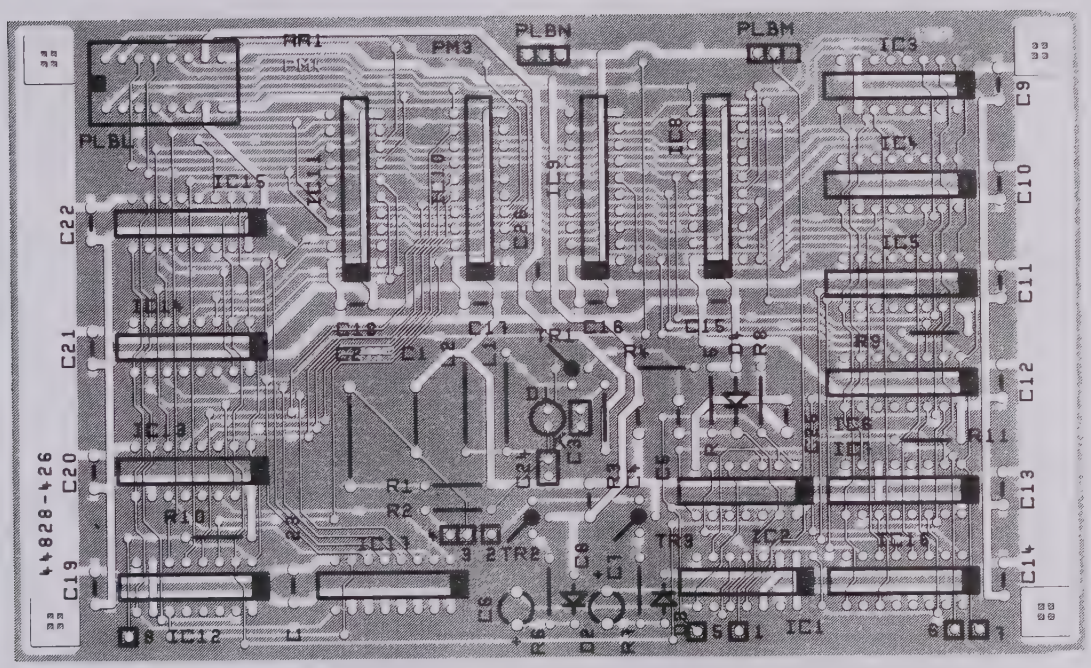
Sep. 81




AA/B0

Fig. 5
Chap. 7
Page 11

oox 1 interconnections, AA/B0




Component layout, AA1

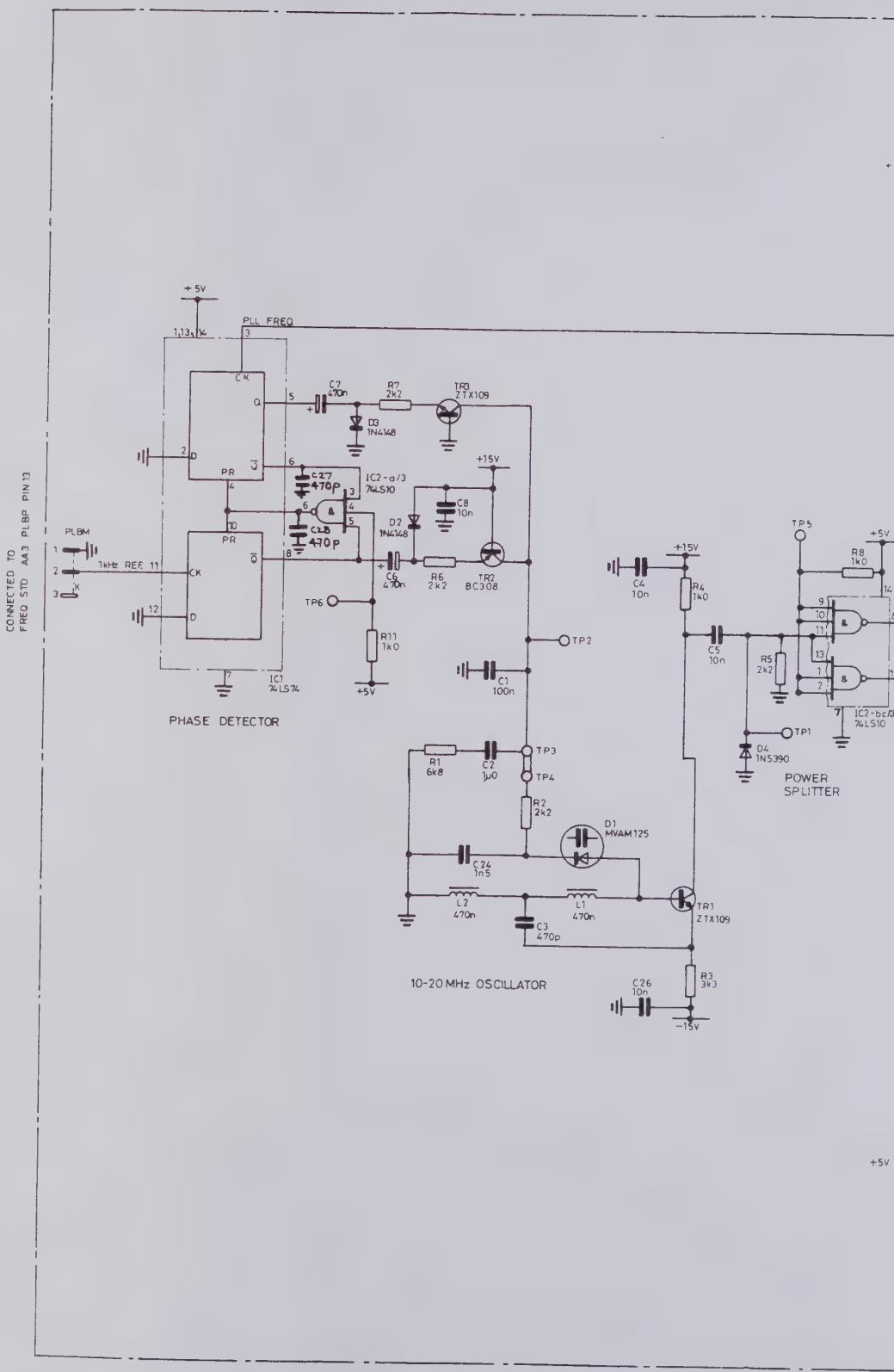
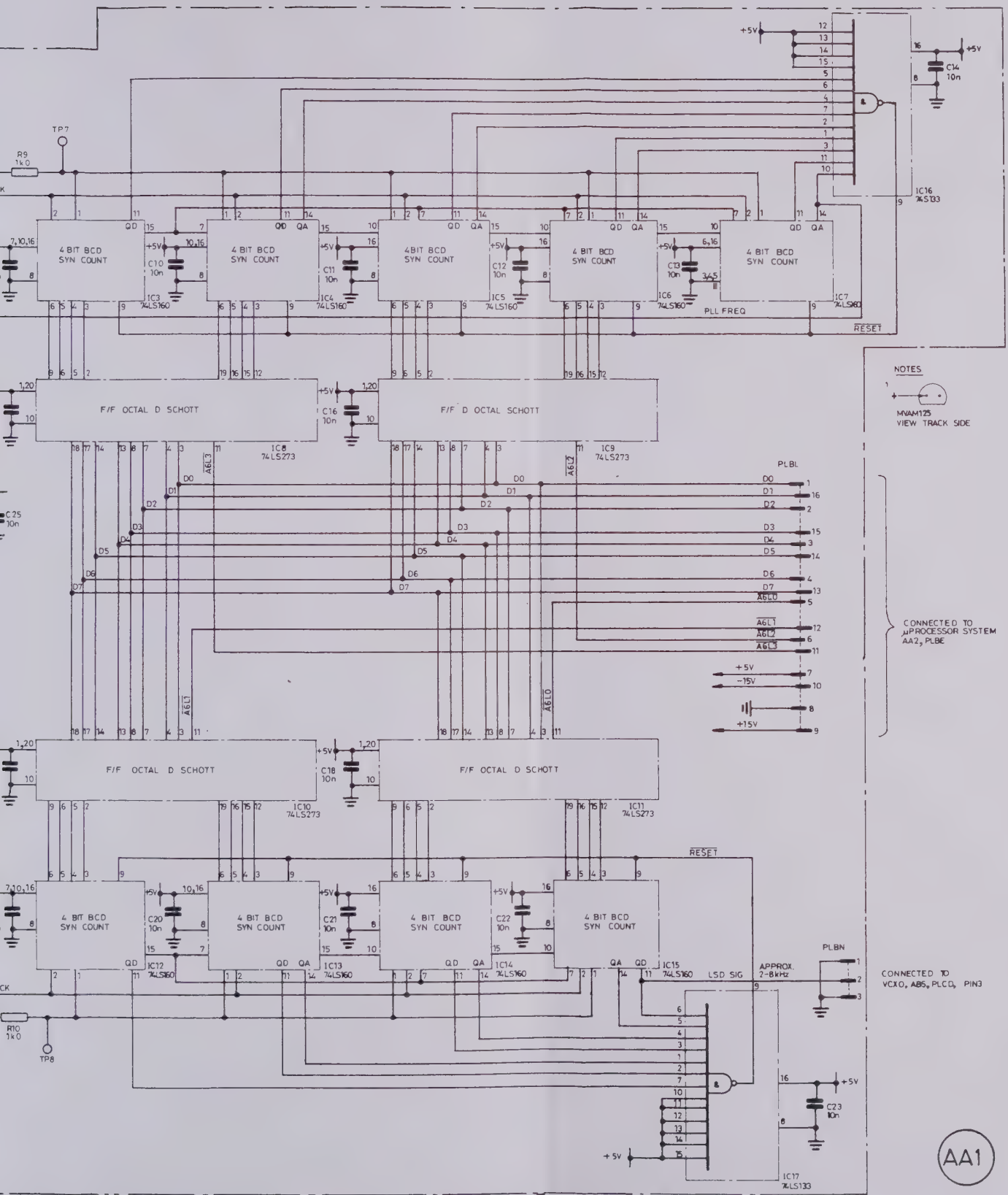

CONNECTED TO
FREQ STD AA3 PLBP PIN 13
PLBM
1kHz REF
PLL FREQ
IC1
74LS74
PHASE DETECTOR
IC2-a/3
74LS10
IC2-b/c/d
74LS10
10-20 MHz OSCILLATOR
POWER
SPLITTER
TR1
ZTX109
TR2
BC308
TR3
ZTX109
D1
MVAM125
D2
1N4148
D3
1N4148
D4
1N5390
TP1
TP2
TP3
TP4
TP5
TP6
+5V
+15V
-15V

Fig. 6

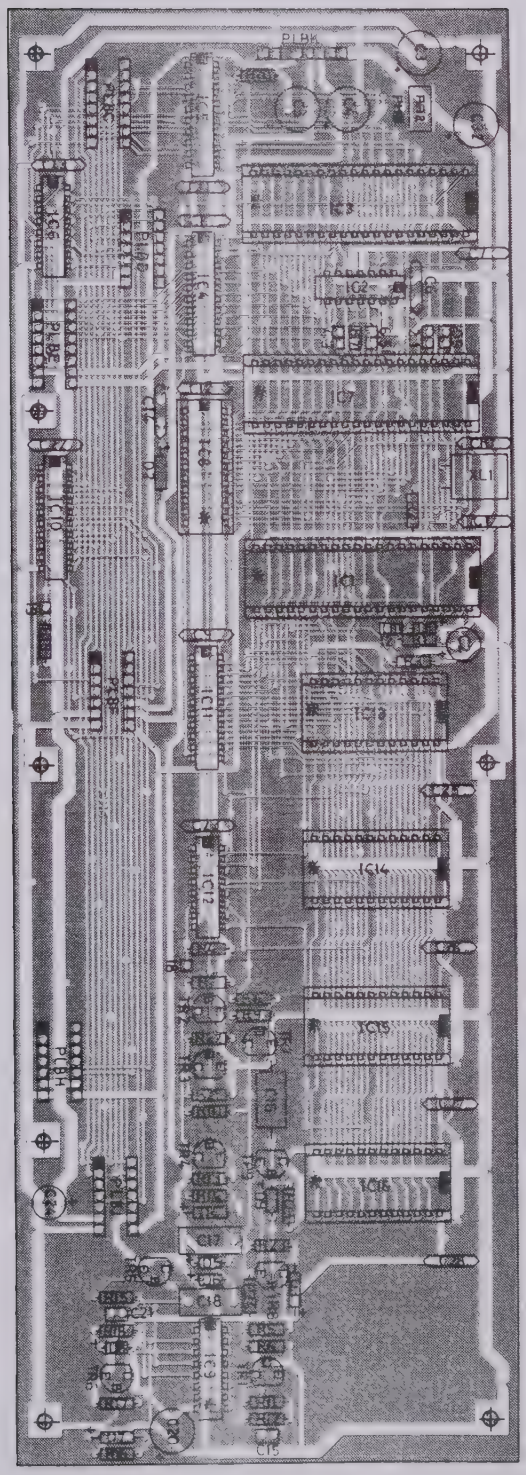
Sep. 81




Z 44828-426W Iss. 6

LSD loop, AA1

AA1

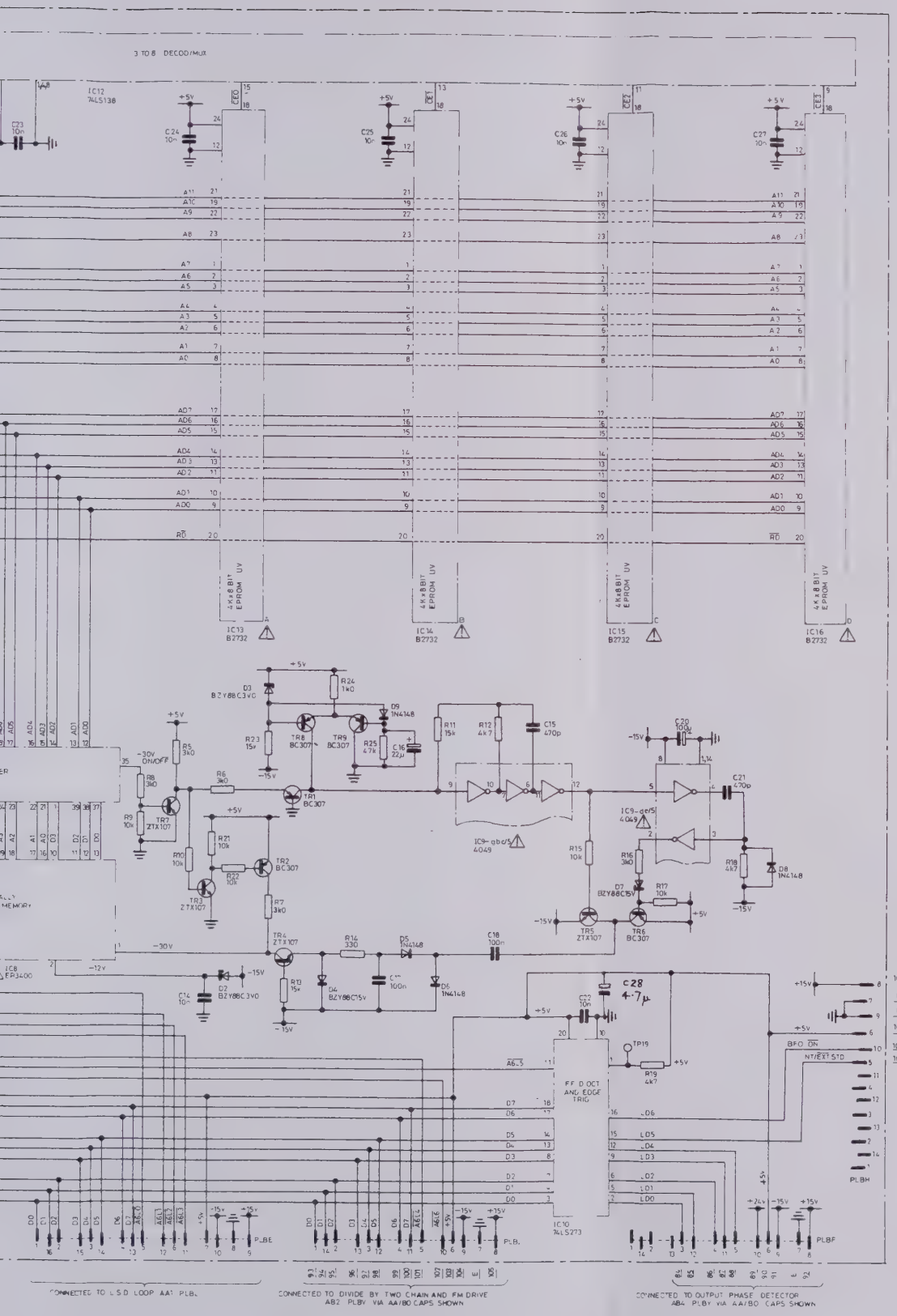


Component layout, AA2

8 BIT MICROPROCESSOR
OCT TRANS LATCH 3ST
2K RAM + I/O + TIMER
OCT BUS TRANSCEIVER
OCT 3 STATE BUFFERS
CONNECTED TO RF BOX1 AA/BO CAPS SHOWN
SEE NOTE2
+5V (MICROPROCESSOR)
CONNECTED TO RF BOX1 AA/BO CAPS SHOWN
TO ABS

Fig. 7

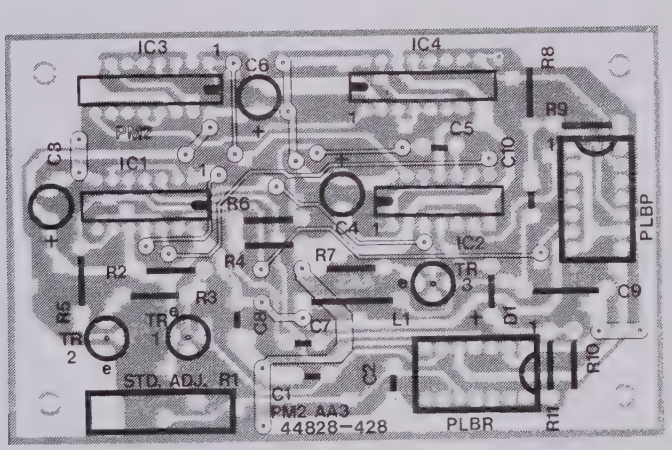
Sep. 81


3 TO 8 DECOD/MUX
IC12 74LS138
IC13 B2732
IC14 B2732
IC15 B2732
IC16 B2732
4K x 8 BIT EPROM UV
NOTES
1 COMPONENTS MARKED ⚠ ARE STATIC SENSITIVE, PRECAUTIONS AS PER MIC2320
2 THE +5V FROM PIN2 PLBK CONNECTS TO THE POINTS SHOWN; THE +5V FROM PIN1 CONNECTS TO ALL OTHER +5V POINTS INDICATED
IC9-ab/5 4049
IC9-cd/5 4049
C28 4·7µ
FF D OCT AND EDGE TRIG
IC10 74LS273
CONNECTED TO FREQ STD AA3 PLBP VIA AA/B0 CAPS SHOWN
CONNECTED TO L.S.D. LOOP AA1 PLBL
CONNECTED TO DIVIDE BY TWO CHAIN AND FM DRIVE AB2 PLBV VIA AA/B0 CAPS SHOWN
CONNECTED TO OUTPUT PHASE DETECTOR AB4 PLBY VIA AA/B0 CAPS SHOWN

Microprocessor system, AA2

Z 44828 - 427D Iss.11

AA2




Component layout, AA3

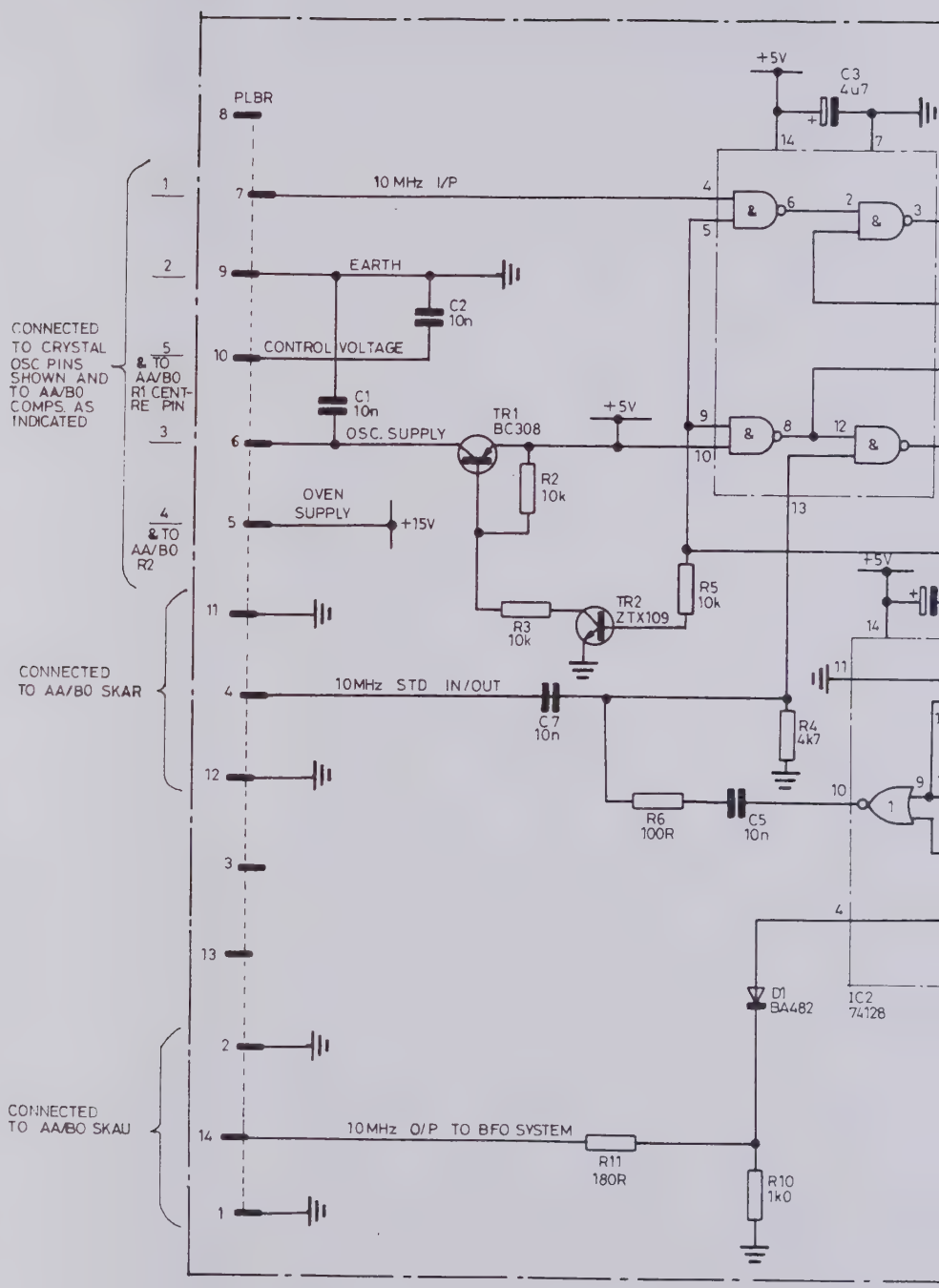
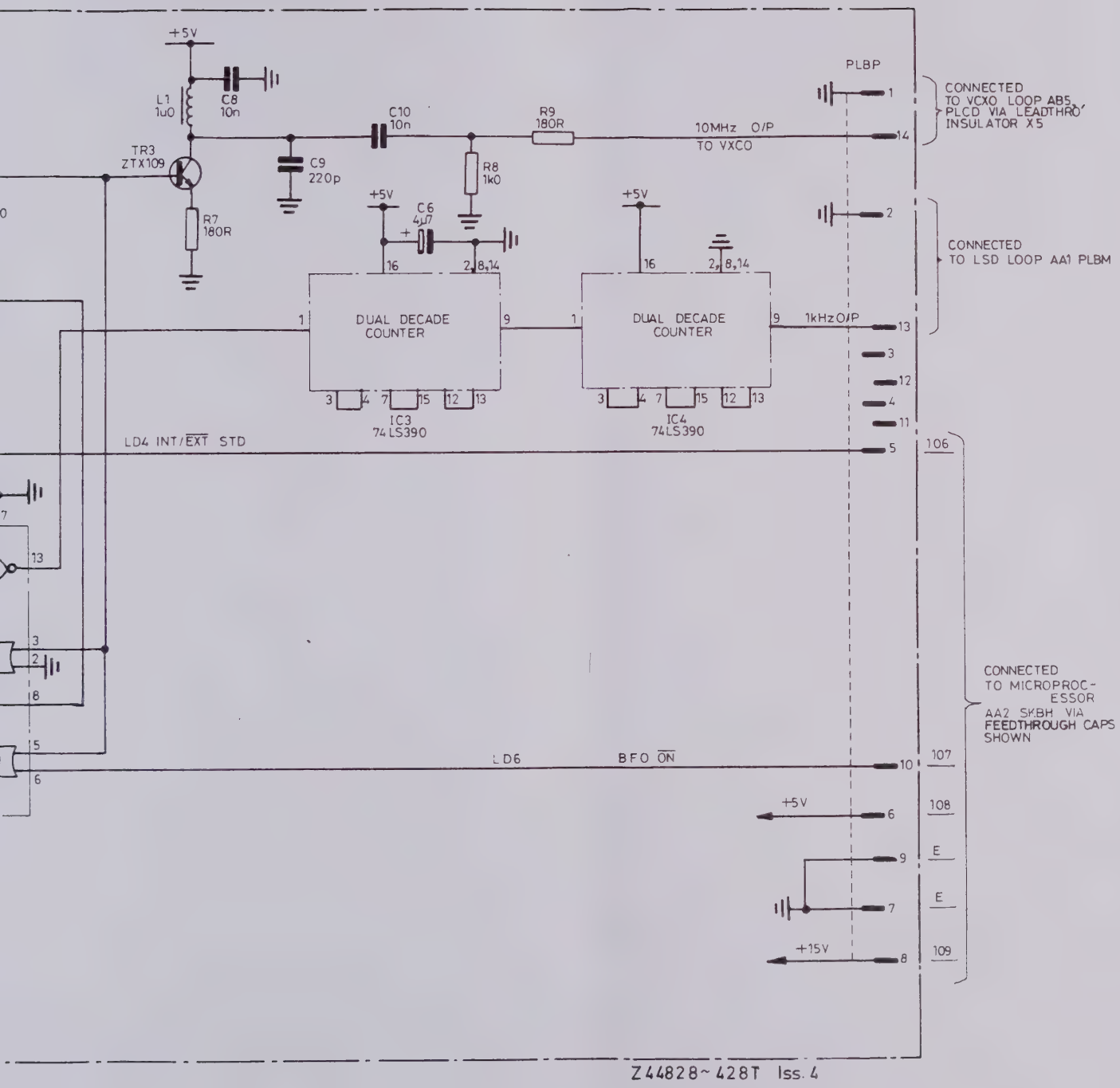

PLBR
10 MHz I/P
EARTH
C2
10n
CONTROL VOLTAGE
C1
10n
OSC. SUPPLY
TR1
BC308
+5V
R2
10k
OVEN
SUPPLY
+15V
R3
10k
TR2
ZTX109
R5
10k
10MHz STD IN/OUT
C7
10n
R4
4k7
R6
100R
C5
10n
C3
4u7
D1
BA482
IC2
74128
10MHz O/P TO BFO SYSTEM
R11
180R
R10
1k0
CONNECTED TO CRYSTAL OSC PINS SHOWN AND TO AA/BO COMPS. AS INDICATED
5 & TO AA/BO R1 CENTRE PIN
4 & TO AA/BO R2
CONNECTED TO AA/BO SKAR
CONNECTED TO AA/BO SKAU

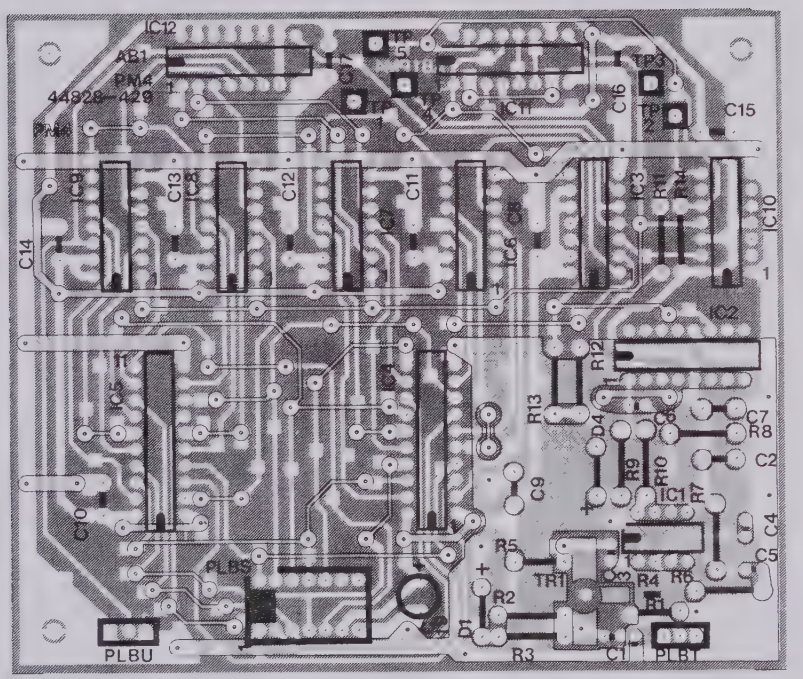
Fig. 8

Sep. 81




Frequency standard, AA3

AA3




Component layout, AB1

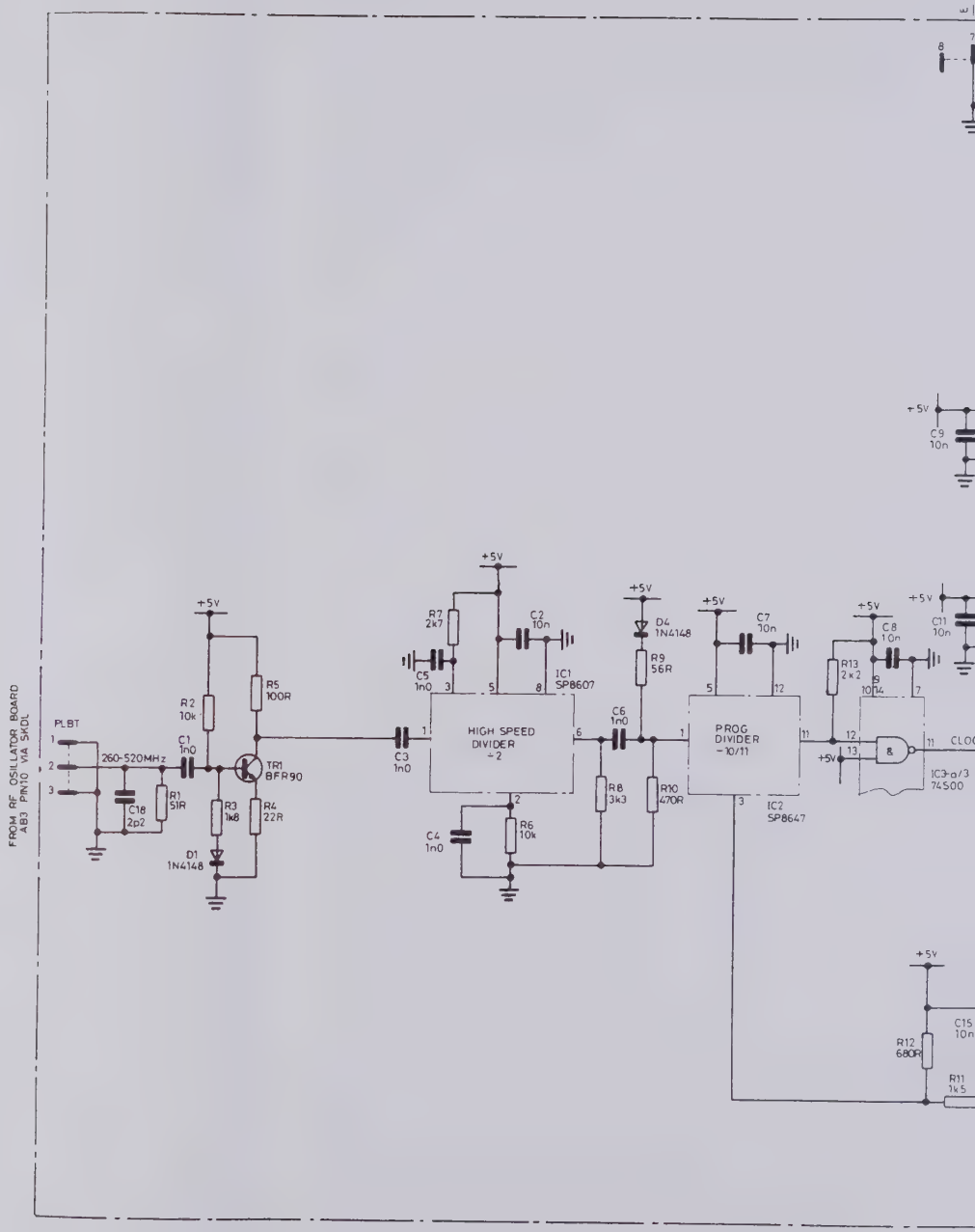
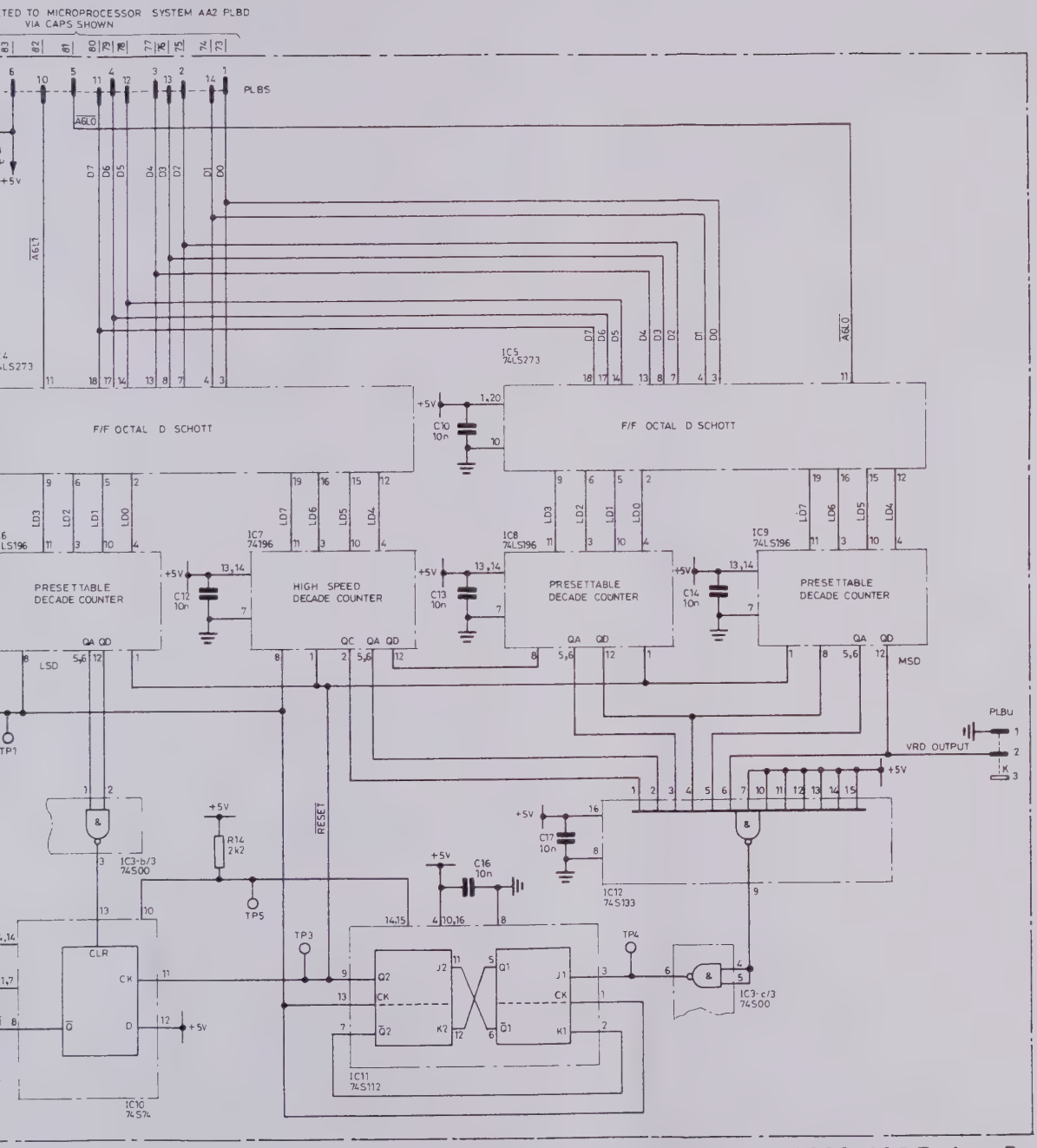

FROM RF OSILLATOR BOARD
AB3 PIN10 VIA SKDL
PLBT
260-520MHz
C18
2p2
R1
51R
C1
1n0
R2
10k
R3
1k8
R4
22R
R5
100R
TR1
BFR90
D1
1N4148
+5V
C3
1n0
R7
2k7
C5
1n0
C2
10n
IC1
SP8607
HIGH SPEED
DIVIDER
÷2
C4
1n0
R6
10k
C6
1n0
D4
1N4148
R9
56R
R8
3k3
R10
470R
PROG
DIVIDER
÷10/11
IC2
SP8647
C7
10n
R13
2×2
C8
10n
C9
10n
C11
10n
IC3-a/3
74S00
CLOC
C15
10n
R12
680R
R11
1k5

Fig. 9

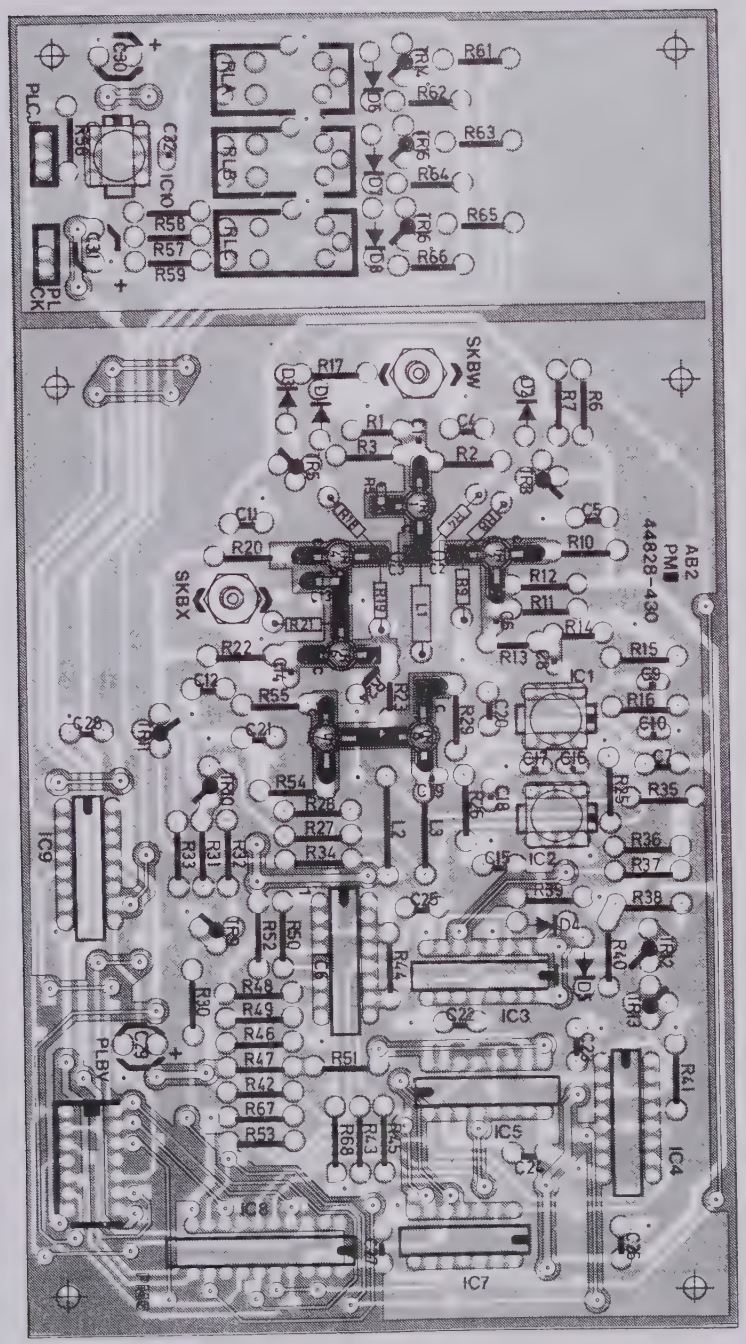
Sep. 81




Z 44828-429P Iss. 5

AB1

Output v.r.d., AB1




Component layout, AB2

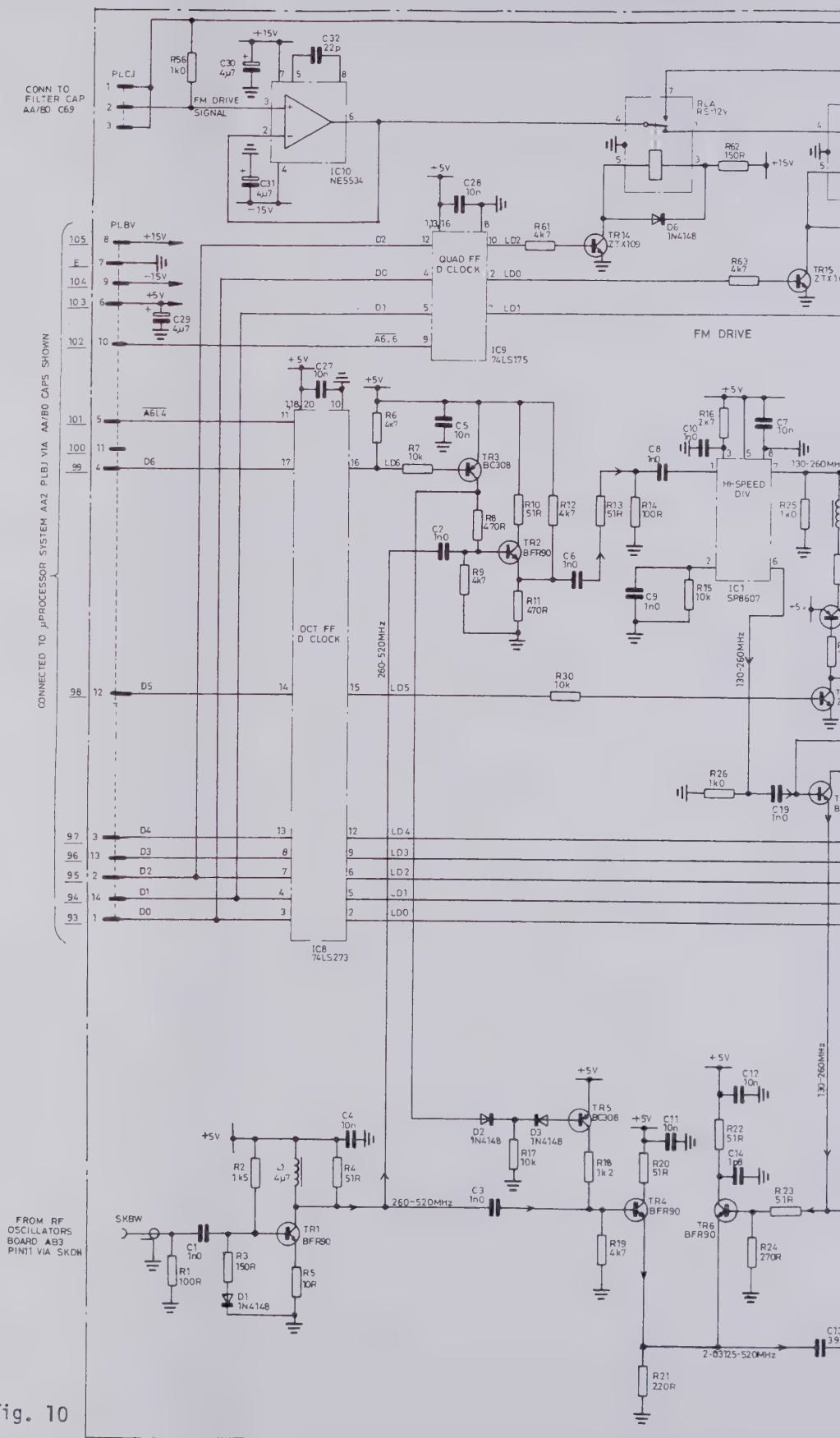
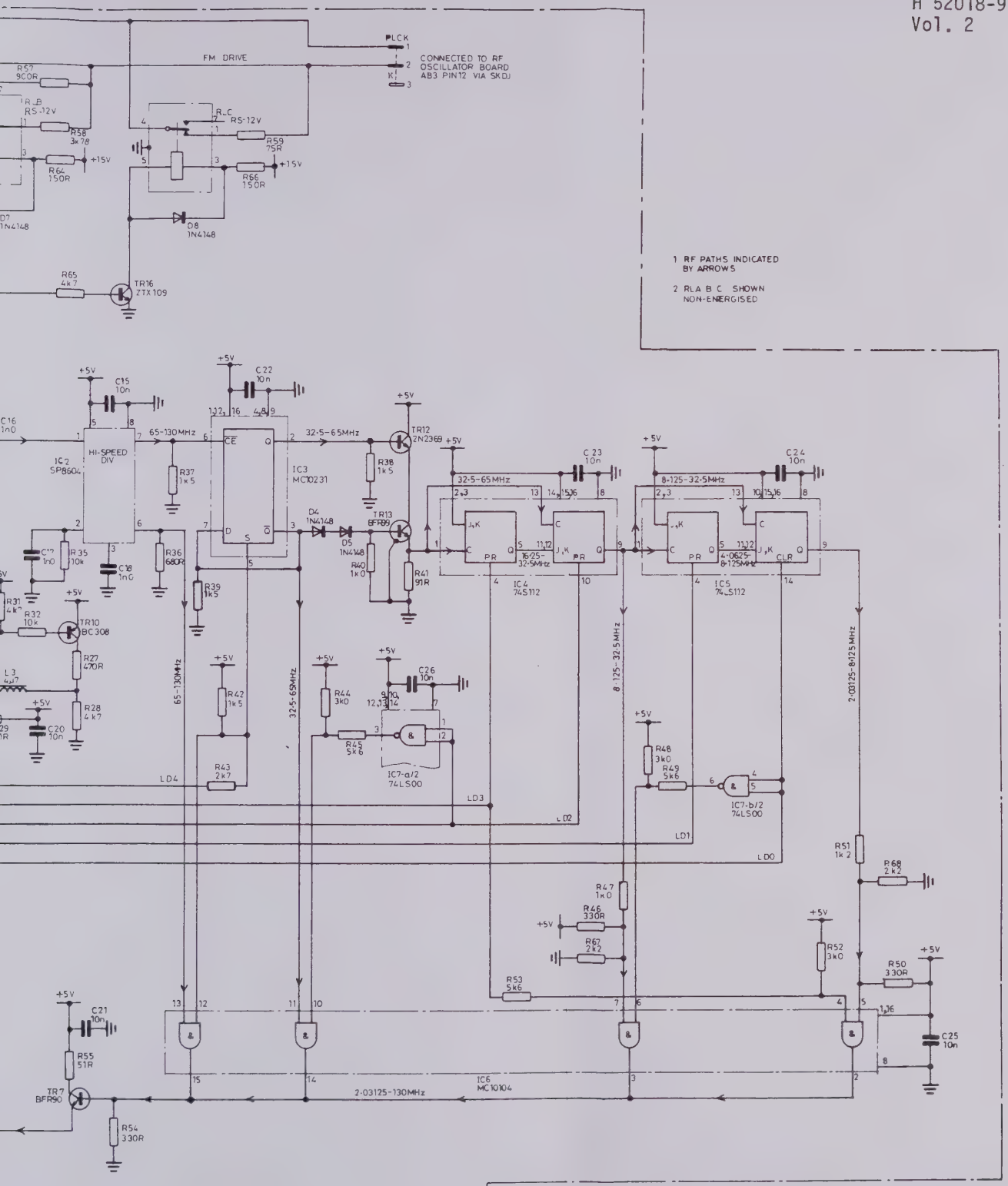

CONN TO FILTER CAP AA/BD C69
PLCJ
FM DRIVE SIGNAL
IC10 NE5534
C32 22p
C30 4µ7
C31 4µ7
+15V
-15V
+5V
C28 10n
R56 1k0
RLA RS-12V
R62 150R
D6 1N4148
TR14 ZTX109
R61 4k7
R63 4k7
TR15 ZTX1
FM DRIVE
PLBV
C29 4µ7
QUAD FF D CLOCK
IC9 74LS175
CONNECTED TO µPROCESSOR SYSTEM AA2 PLBJ VIA AA/BD CAPS SHOWN
C27 10n
R6 4k7
C5 10n
R7 10k
TR3 BC308
R16 2k7
C10 1n0
C7 10n
C8 1n0
MH SPEED DIV
130-260MHz
R10 51R
R12 4k7
R13 51R
R14 100R
R8 470R
C2 1n0
TR2 BFR90
C6 1n0
R9 4k7
R11 470R
C9 1n0
R15 10k
IC1 SP8607
R25 1k0
OCT FF D CLOCK
260-520MHz
R30 10k
R26 1k0
C19 1n0
IC8 74LS273
C4 10n
R2 1k5
L1 4µ7
R4 51R
D2 1N4148
D3 1N4148
TR5 BC308
R17 10k
R18 1k2
C11 10n
R20 51R
C12 10n
R22 51R
C14 1p8
R23 51R
C3 1n0
TR4 BFR90
TR6 BFR90
R19 4k7
R24 270R
FROM RF OSCILLATORS BOARD AB3 PIN11 VIA SKDH
SKBW
C1 1n0
R1 100R
R3 150R
R5 10R
TR1 BFR90
D1 1N4148
2·03125-520MHz
R21 220R

Fig. 10

Sep. 81

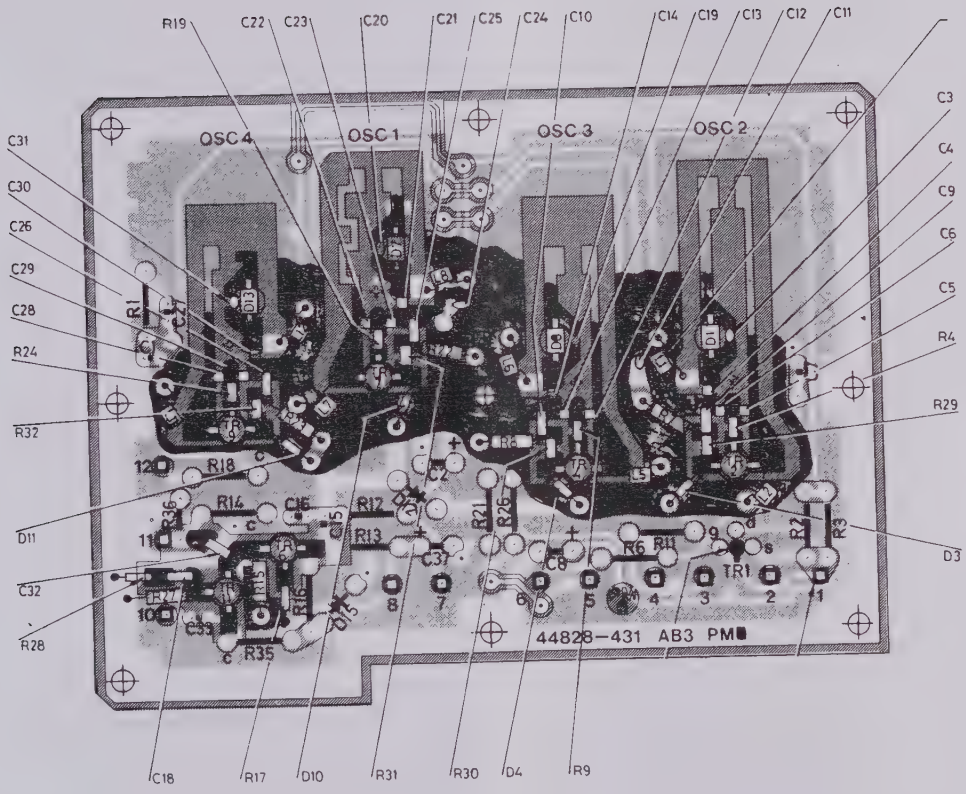



DIVIDE BY 2 CHAIN

Z44828-430D Iss.7

Divide by 2 chain and f.m. drive, AB2

AB2




Component layout, AB3

Fig. 11a
Chap. 7
Page 22

Fig. 11a

Sep. 81

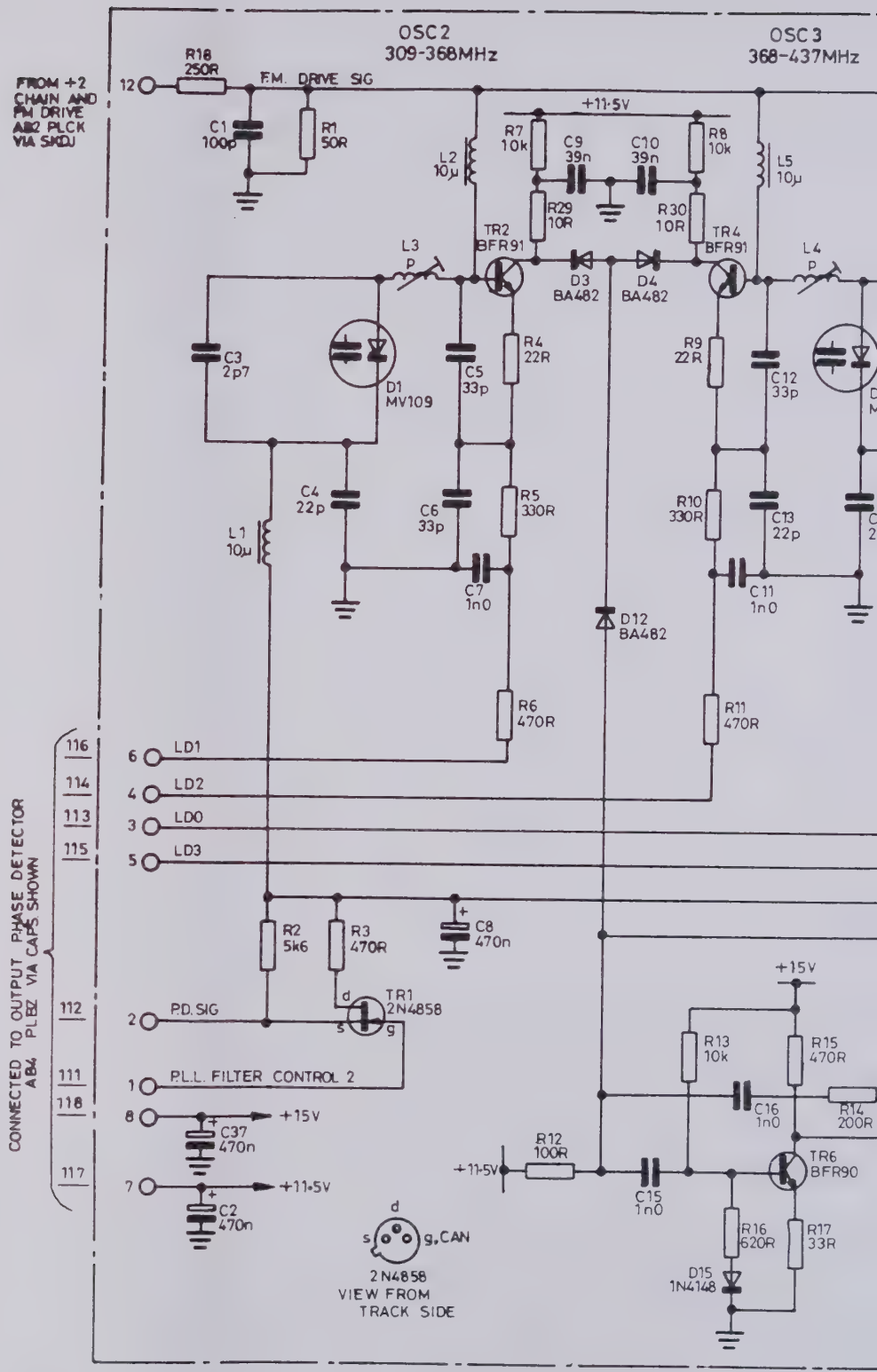
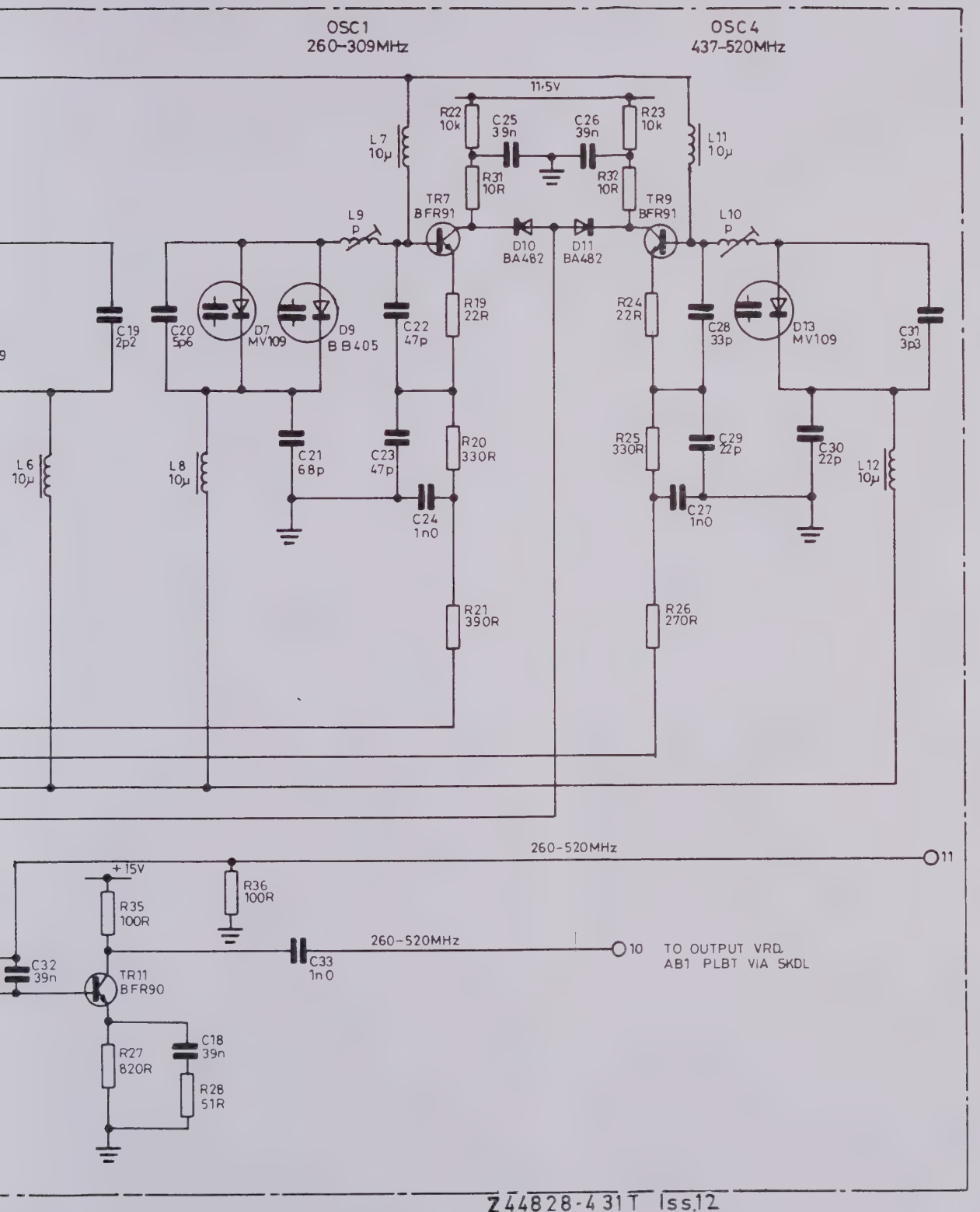

OSC2
309-368MHz
OSC3
368-437MHz
FROM +2 CHAIN AND FM DRIVE AB2 PLCK VIA SKDJ
R18 250R
F.M. DRIVE SIG
C1 100p
R1 50R
+11·5V
R7 10k
C9 39n
C10 39n
R8 10k
L2 10µ
L5 10µ
R29 10R
R30 10R
TR2 BFR91
TR4 BFR91
L3
L4
D3 BA482
D4 BA482
C3 2p7
D1 MV109
C5 33p
R4 22R
R9 22R
C12 33p
C4 22p
C6 33p
R5 330R
R10 330R
C13 22p
L1 10µ
C7 1n0
C11 1n0
D12 BA482
R6 470R
R11 470R
CONNECTED TO OUTPUT PHASE DETECTOR AB4 PL8Z VIA CAPS SHOWN
LD1
LD2
LD0
LD3
R2 5k6
R3 470R
C8 470n
TR1 2N4858
P.D. SIG
P.L.L. FILTER CONTROL 2
+15V
C37 470n
+11·5V
C2 470n
2N4858 VIEW FROM TRACK SIDE
g, CAN
+15V
R13 10k
R15 470R
C16 1n0
R14 200R
R12 100R
TR6 BFR90
C15 1n0
R16 620R
R17 33R
D15 1N4148

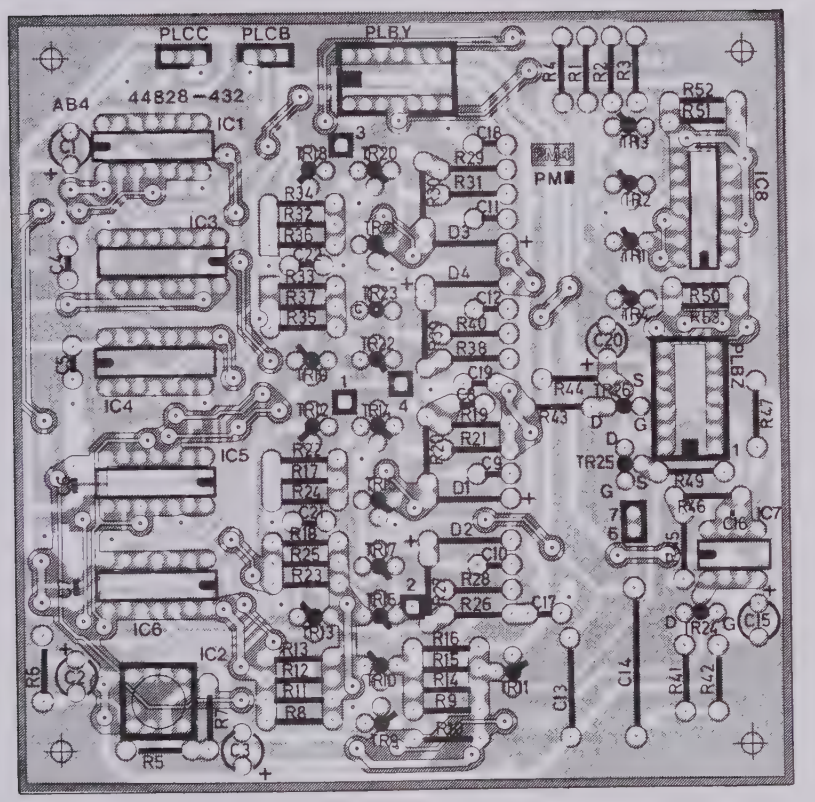
Fig. 11

Sep. 81




RF oscillators board, AB3

AB3




Component layout, AB4

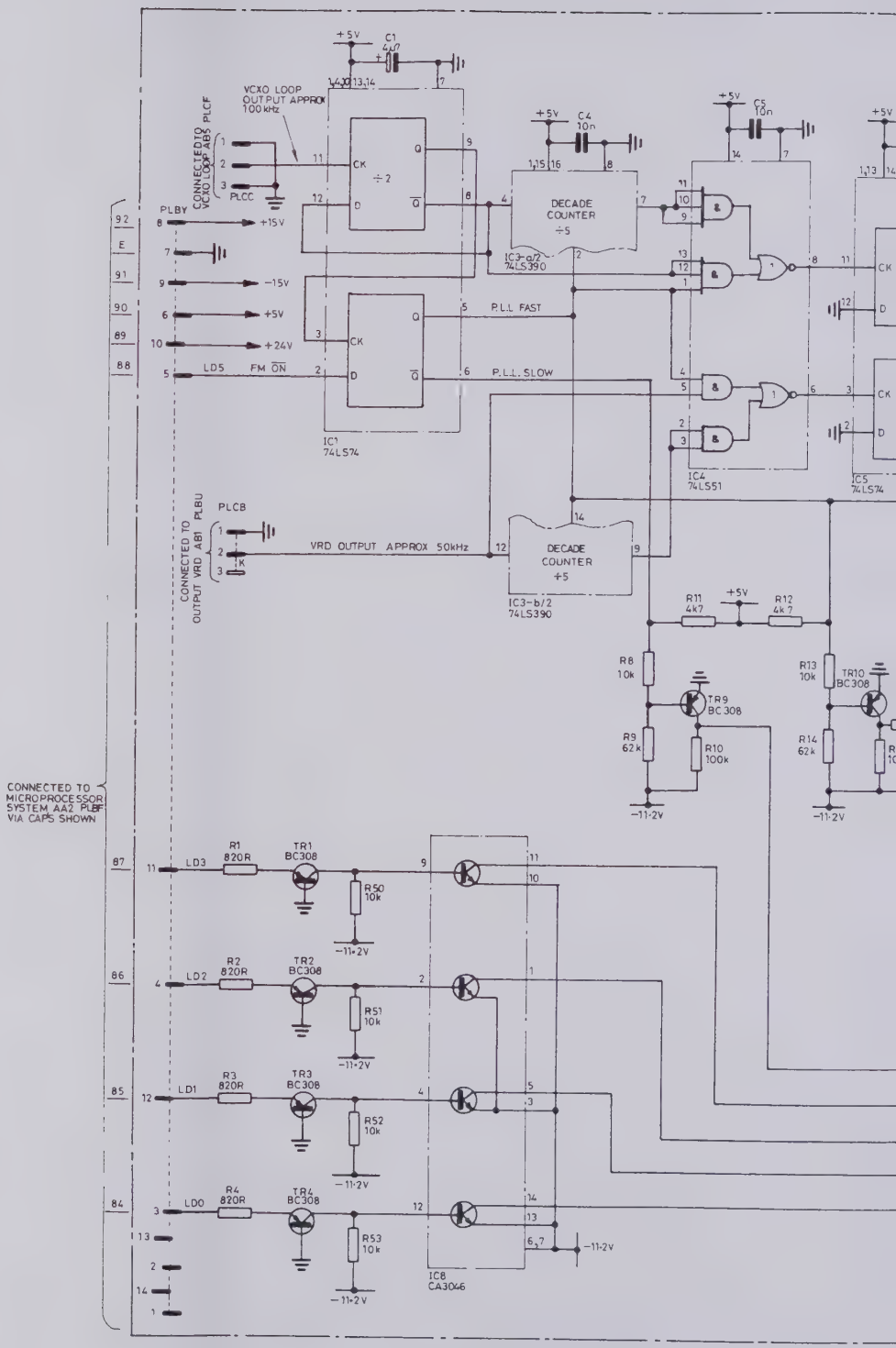
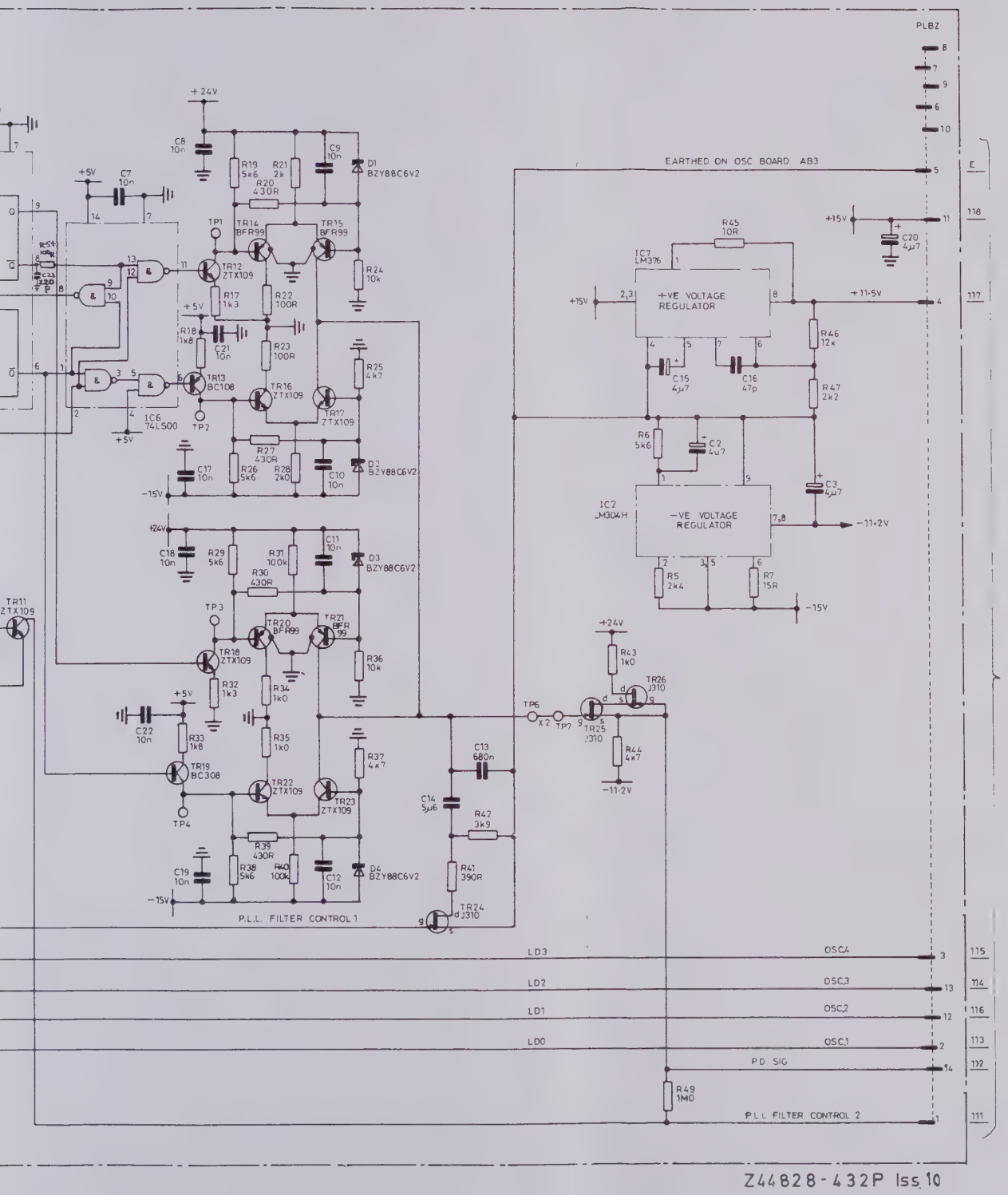

+5V
C1
4u7
VCXO LOOP OUTPUT APPROX 100kHz
CONNECTED TO VCXO LOOP ABS PLCF
PLCC
PLBY
+15V
-15V
+5V
+24V
LD5
FM ON
IC1
74LS74
P.L.L. FAST
P.L.L. SLOW
DECADE COUNTER ÷5
IC3-a/2
74LS390
C4
10n
C5
10n
IC4
74LS51
IC5
74LS74
PLCB
CONNECTED TO OUTPUT VRD ABI PLBU
VRD OUTPUT APPROX 50kHz
IC3-b/2
74LS390
R11
4k7
R12
4k7
R8
10k
R9
62k
R10
100k
TR9
BC308
R13
10k
R14
62k
TR10
BC308
-11·2V
CONNECTED TO MICROPROCESSOR SYSTEM AA2 PLBF VIA CAPS SHOWN
LD3
LD2
LD1
LD0
R1
820R
R2
820R
R3
820R
R4
820R
TR1
BC308
TR2
BC308
TR3
BC308
TR4
BC308
R50
10k
R51
10k
R52
10k
R53
10k
IC8
CA3046

Fig. 12

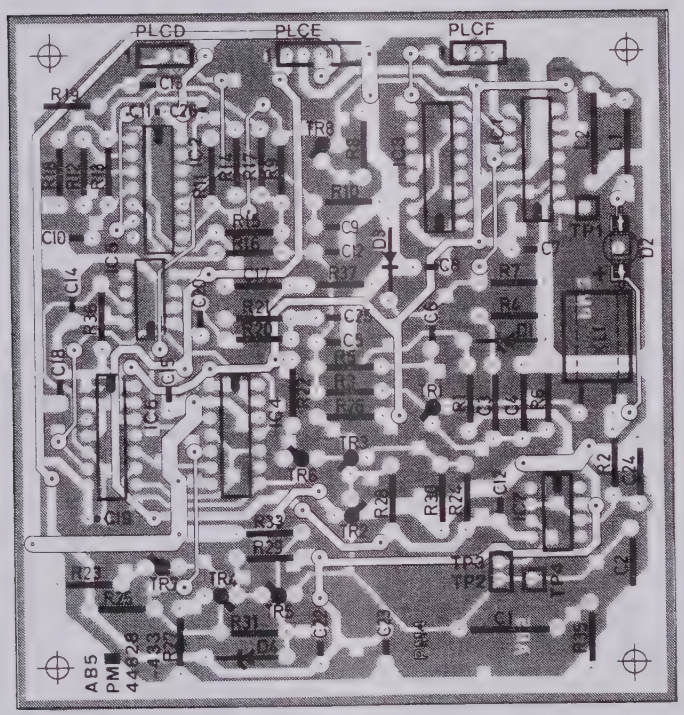
Sep. 81




Z44828-432P Iss 10

AB4

Output phase detector, AB4




Component layout, AB5

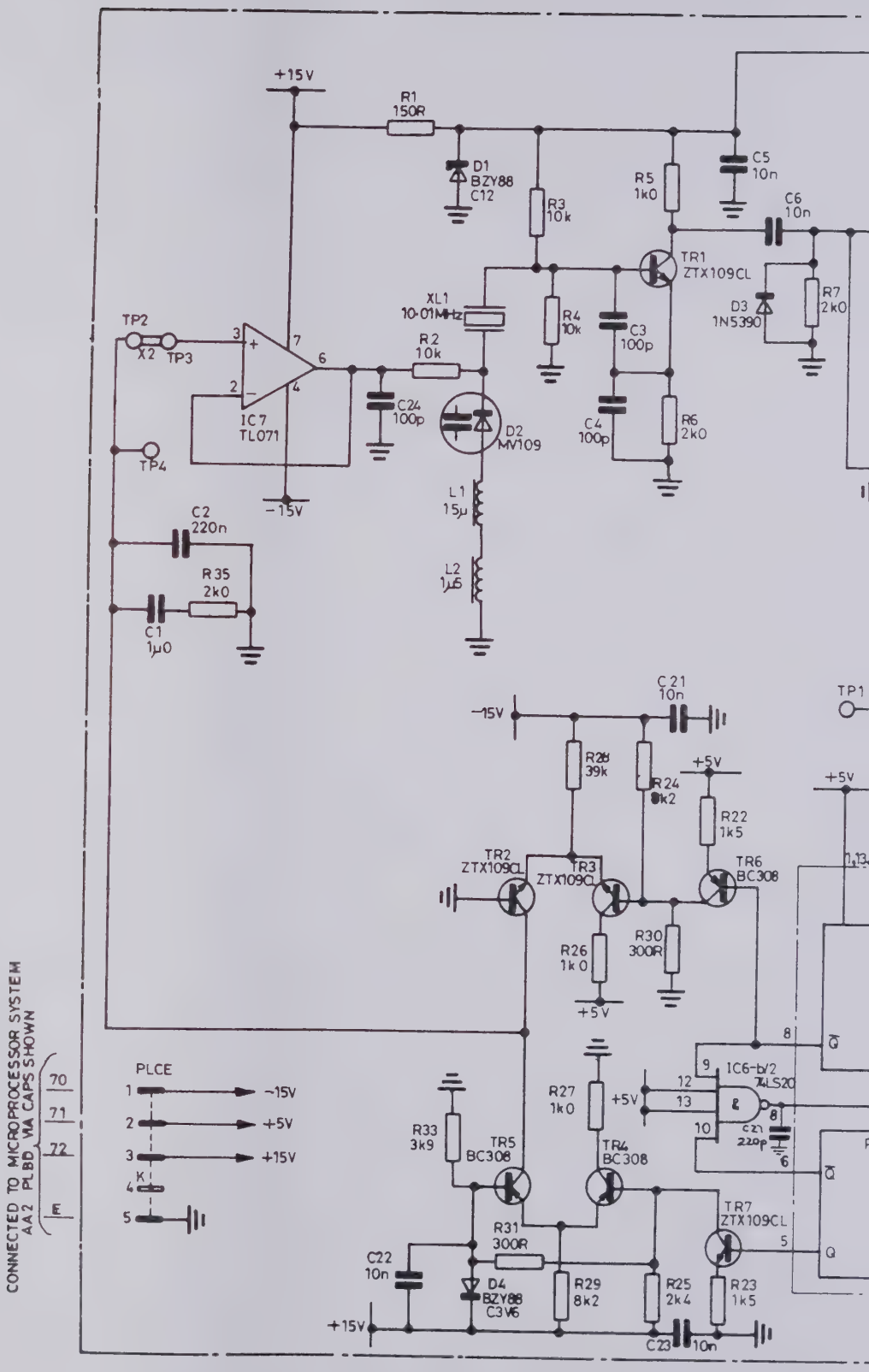
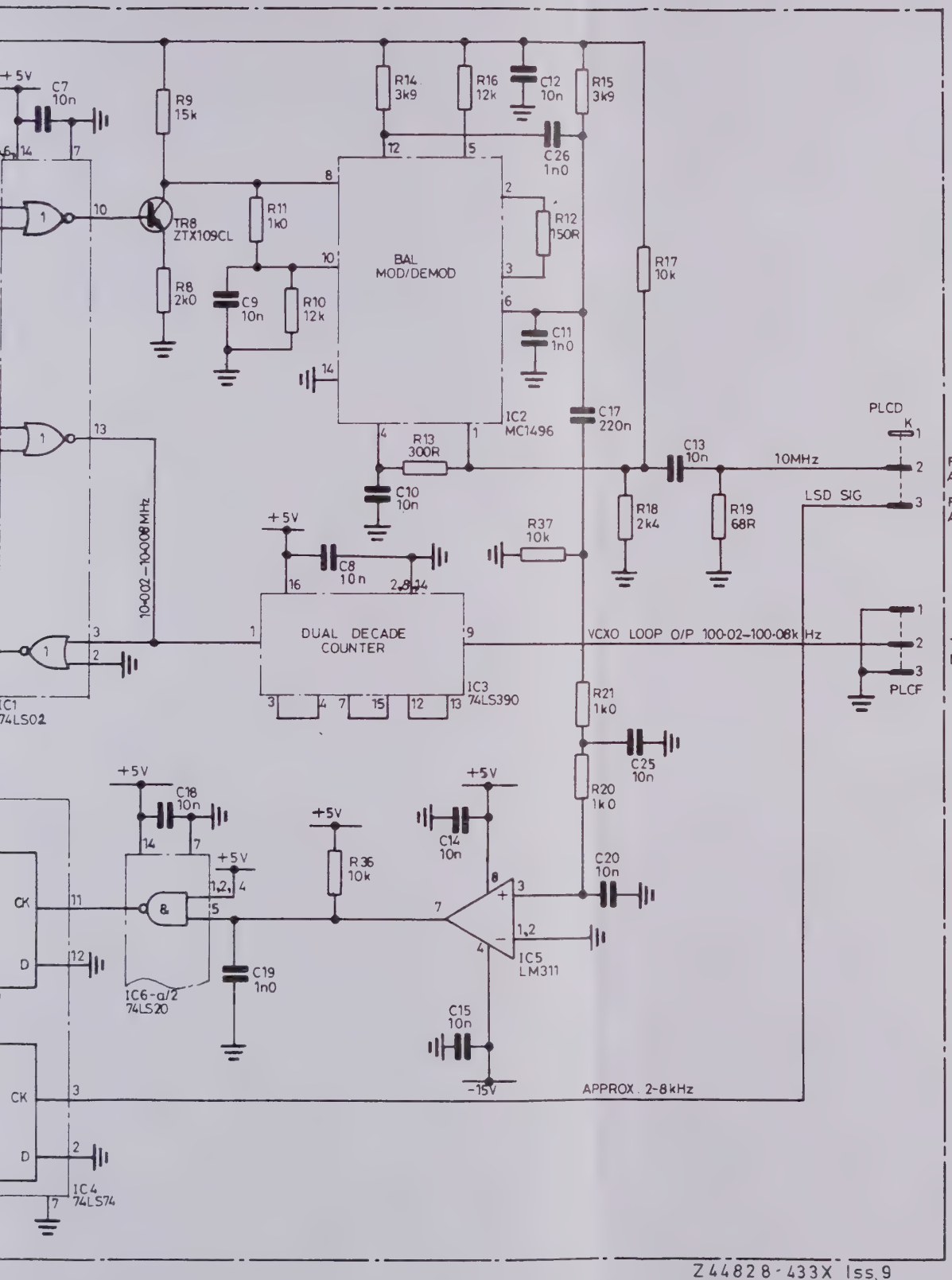



Fig. 13 Voltage co

Sep. 81




trolled crystal oscillator loop, AB5

AB5

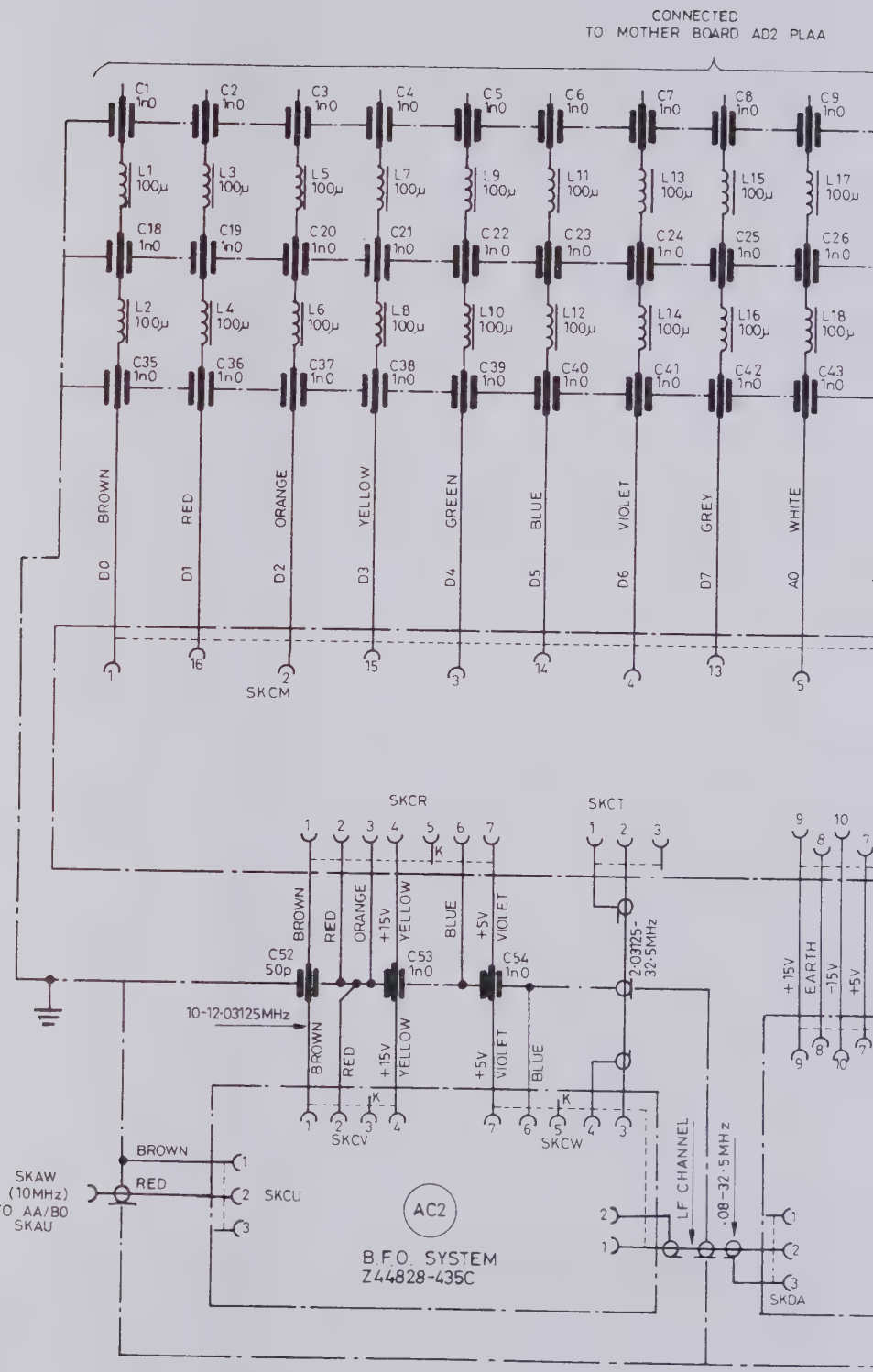
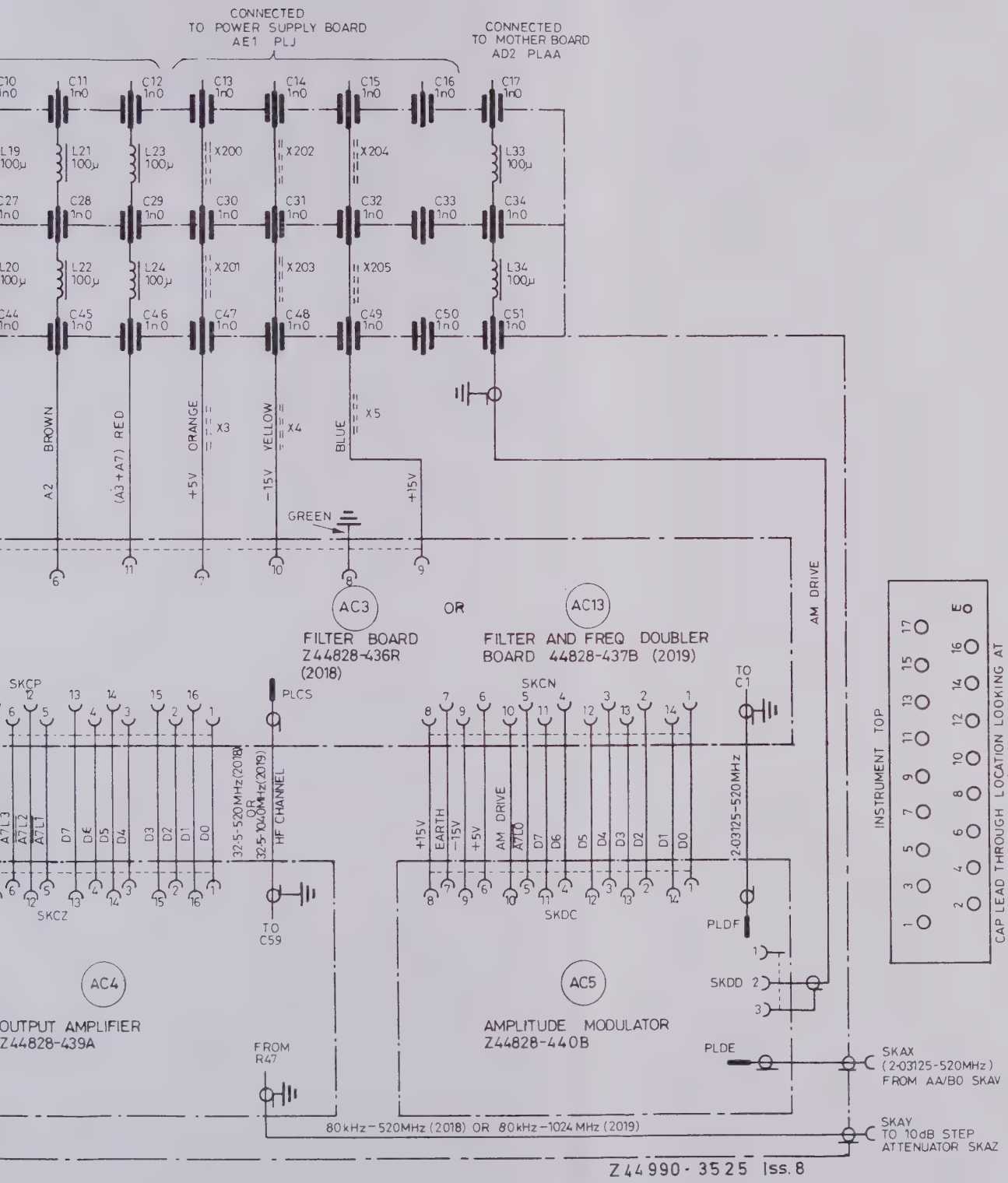
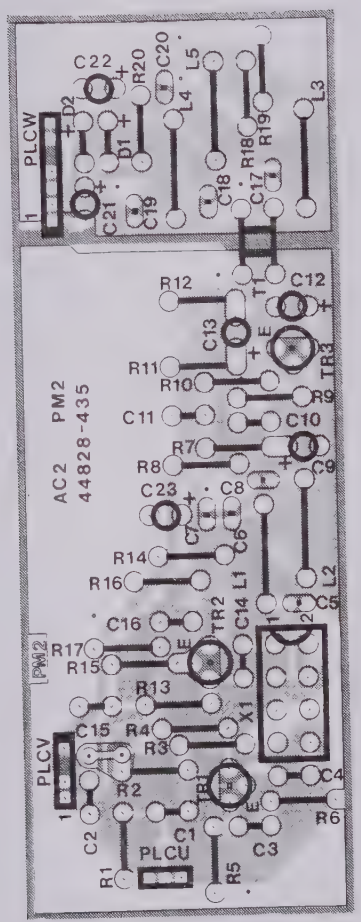

CONNECTED
TO MOTHER BOARD AD2 PLAA
C1 1n0
C2 1n0
C3 1n0
C4 1n0
C5 1n0
C6 1n0
C7 1n0
C8 1n0
C9 1n0
L1 100µ
L3 100µ
L5 100µ
L7 100µ
L9 100µ
L11 100µ
L13 100µ
L15 100µ
L17 100µ
C18 1n0
C19 1n0
C20 1n0
C21 1n0
C22 1n0
C23 1n0
C24 1n0
C25 1n0
C26 1n0
L2 100µ
L4 100µ
L6 100µ
L8 100µ
L10 100µ
L12 100µ
L14 100µ
L16 100µ
L18 100µ
C35 1n0
C36 1n0
C37 1n0
C38 1n0
C39 1n0
C40 1n0
C41 1n0
C42 1n0
C43 1n0
D0 BROWN
D1 RED
D2 ORANGE
D3 YELLOW
D4 GREEN
D5 BLUE
D6 VIOLET
D7 GREY
A0 WHITE
SKCM
SKCR
SKCT
BROWN
RED
ORANGE
+15V
YELLOW
BLUE
+5V
VIOLET
C52 50p
C53 1n0
C54 1n0
2·03125-32·5MHz
10-12·03125MHz
SKCV
SKCW
+15V
EARTH
-15V
+5V
SKAW (10MHz) TO AA/B0 SKAU
SKCU
AC2
B.F.O. SYSTEM
Z44828-435C
LF CHANNEL
·08-32·5MHz
SKDA

Fig. 14

Sep. 81




RF box 2 interconnections, AC0




Component layout, AC2

Fig. 15a

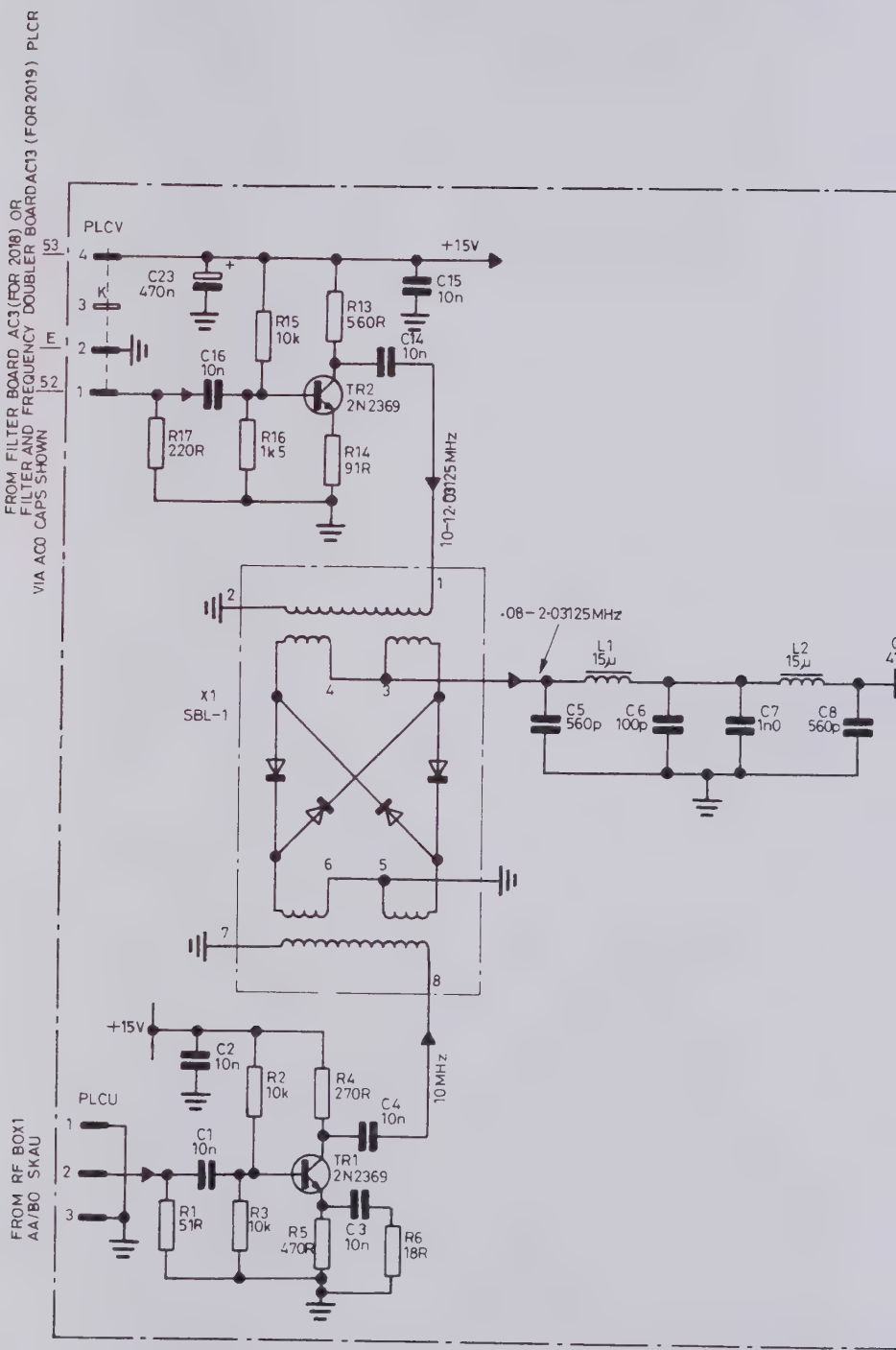
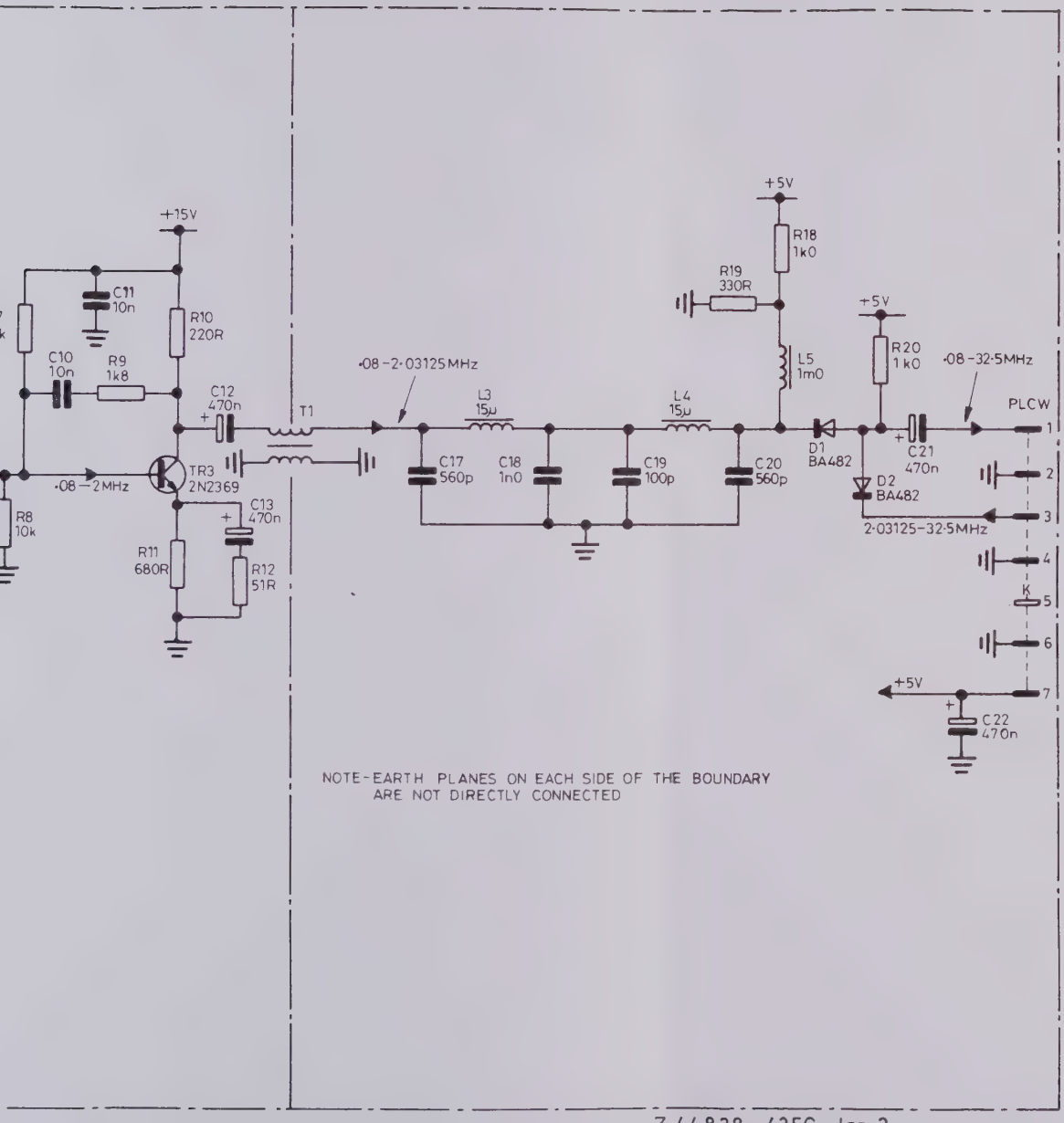

FROM FILTER BOARD AC3 (FOR 2018) OR
FILTER AND FREQUENCY DOUBLER BOARD AC13 (FOR 2019) PLCR
VIA ACO CAPS SHOWN
PLCV
53
52
+15V
C23
470n
C15
10n
R13
560R
R15
10k
C14
10n
C16
10n
TR2
2N2369
R17
220R
R16
1k5
R14
91R
10-12.03125MHz
·08-2·03125MHz
L1
15µ
L2
15µ
X1
SBL-1
C5
560p
C6
100p
C7
1n0
C8
560p
+15V
C2
10n
R2
10k
R4
270R
C4
10n
10MHz
PLCU
C1
10n
TR1
2N2369
R1
51R
R3
10k
R5
470R
C3
10n
R6
18R
FROM RF BOX1
AA/BO SKAU

Fig. 15

Sep. 81




Z 44828 - 435C Iss. 2

AC2

BFO system, AC2

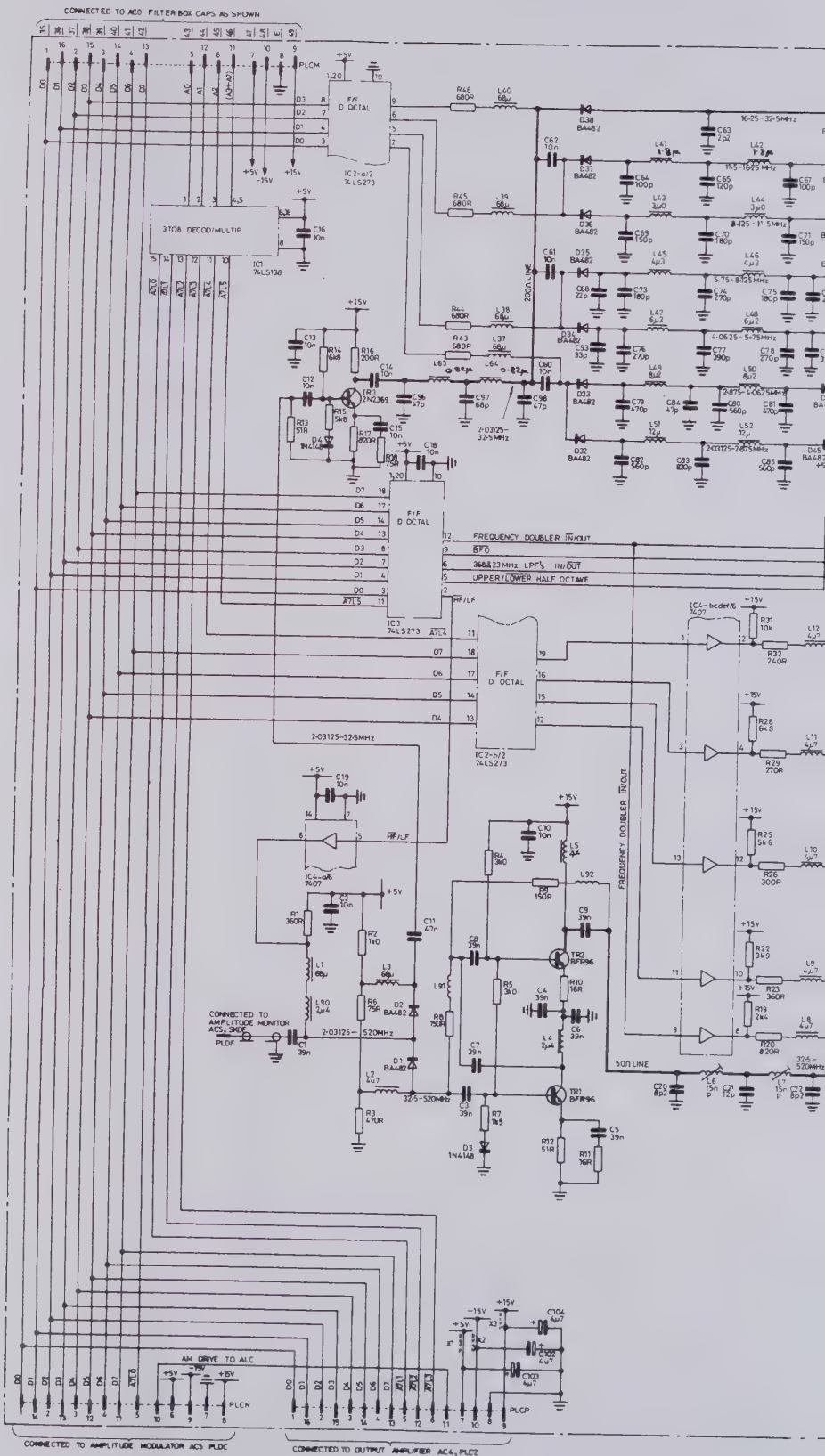
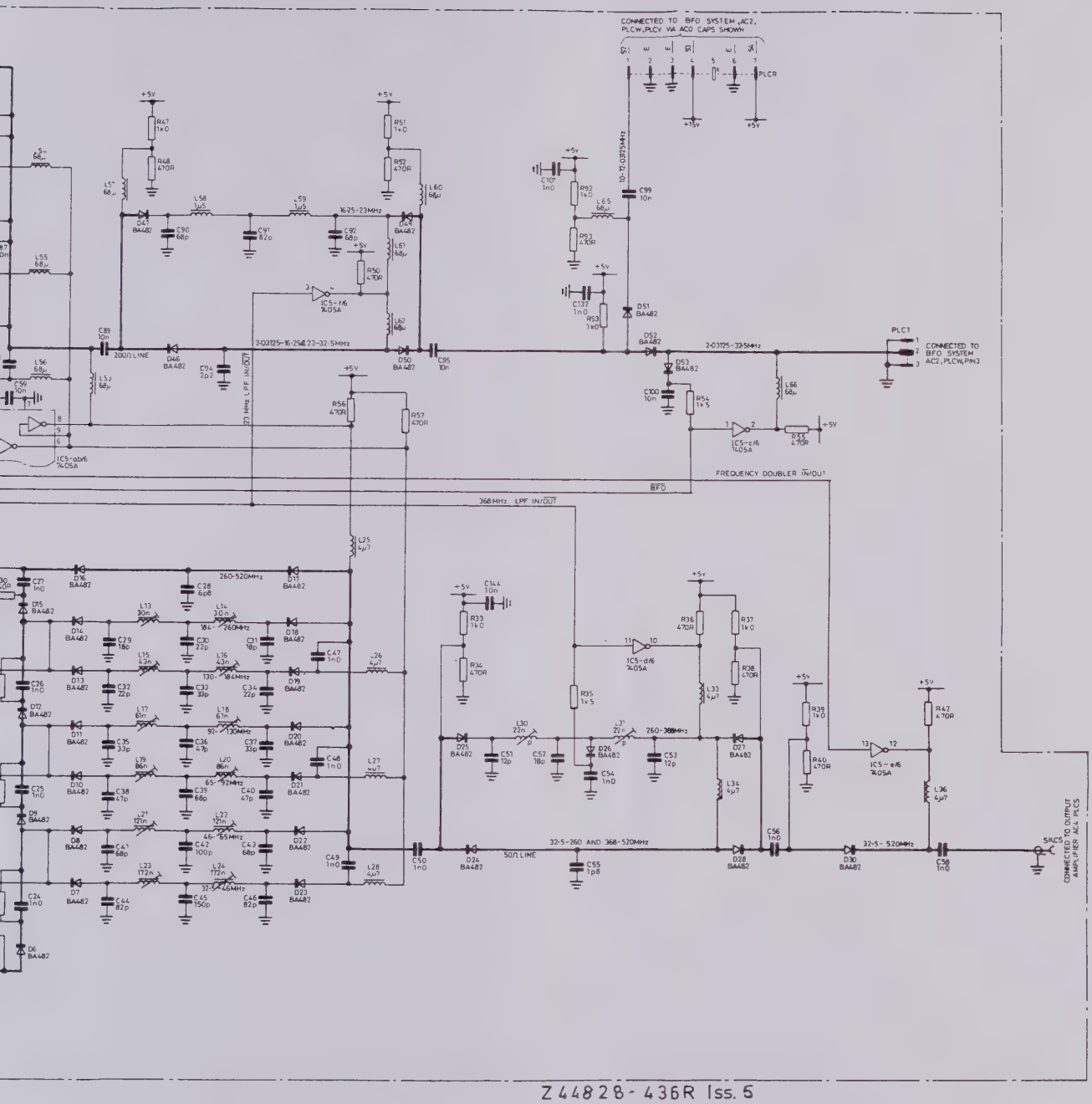

CONNECTED TO ACO FILTER BOX CAPS AS SHOWN
PLCM
F/F D OCTAL
IC2-a/2 74LS273
3 TO 8 DECOD/MULTIP
IC1 74LS138
TR3 2N2369
TR2 BFR96
TR1 BFR96
IC3 74LS273
IC2-b/2 74LS273
IC4-bcdef/6 7407
IC4-a/6 7407
FREQUENCY DOUBLER IN/OUT
BFO
368&23MHz LPF's IN/OUT
UPPER/LOWER HALF OCTAVE
HF/LF
2-03125-32·5MHz
2-03125-520MHz
SON LINE
CONNECTED TO AMPLITUDE MONITOR ACS, SKCF
PLDF
AM DRIVE TO ALC
PLCN
PLCP
CONNECTED TO AMPLITUDE MODULATOR ACS PLDC
CONNECTED TO OUTPUT AMPLIFIER AC4, PLC2

Fig. 16

Sep. 81

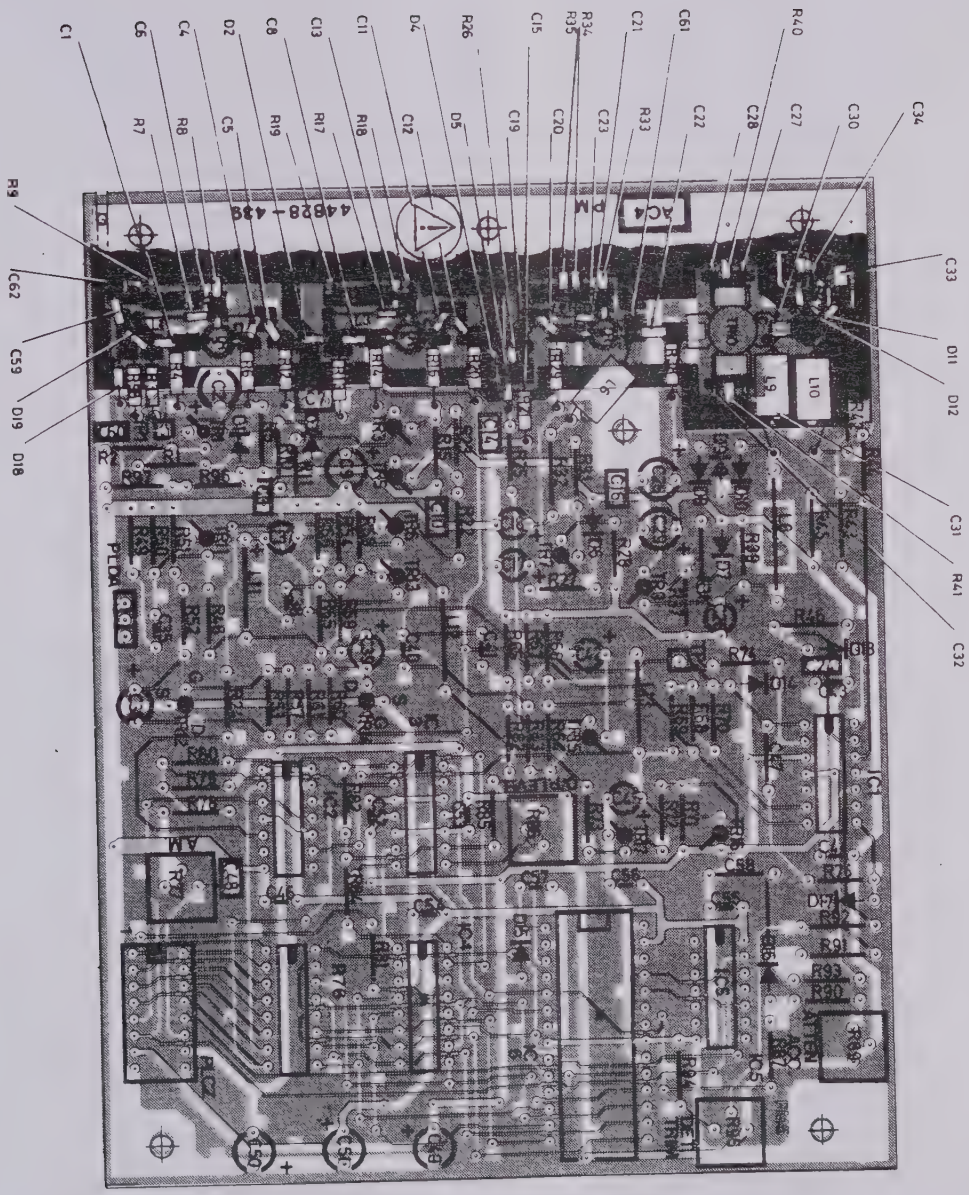



Z44828-436R Iss. 5

NOTES
1 THE BOLD LINES SHOW THE 50Ω AND 200Ω STRAP LINES.
2 DIODES D55,56,57 ARE A SET, CODE 44529-058G

AC3

Filter board, AC3 (for component layout see Fig. 19a)




Component layout, AC4

Fig. 17a

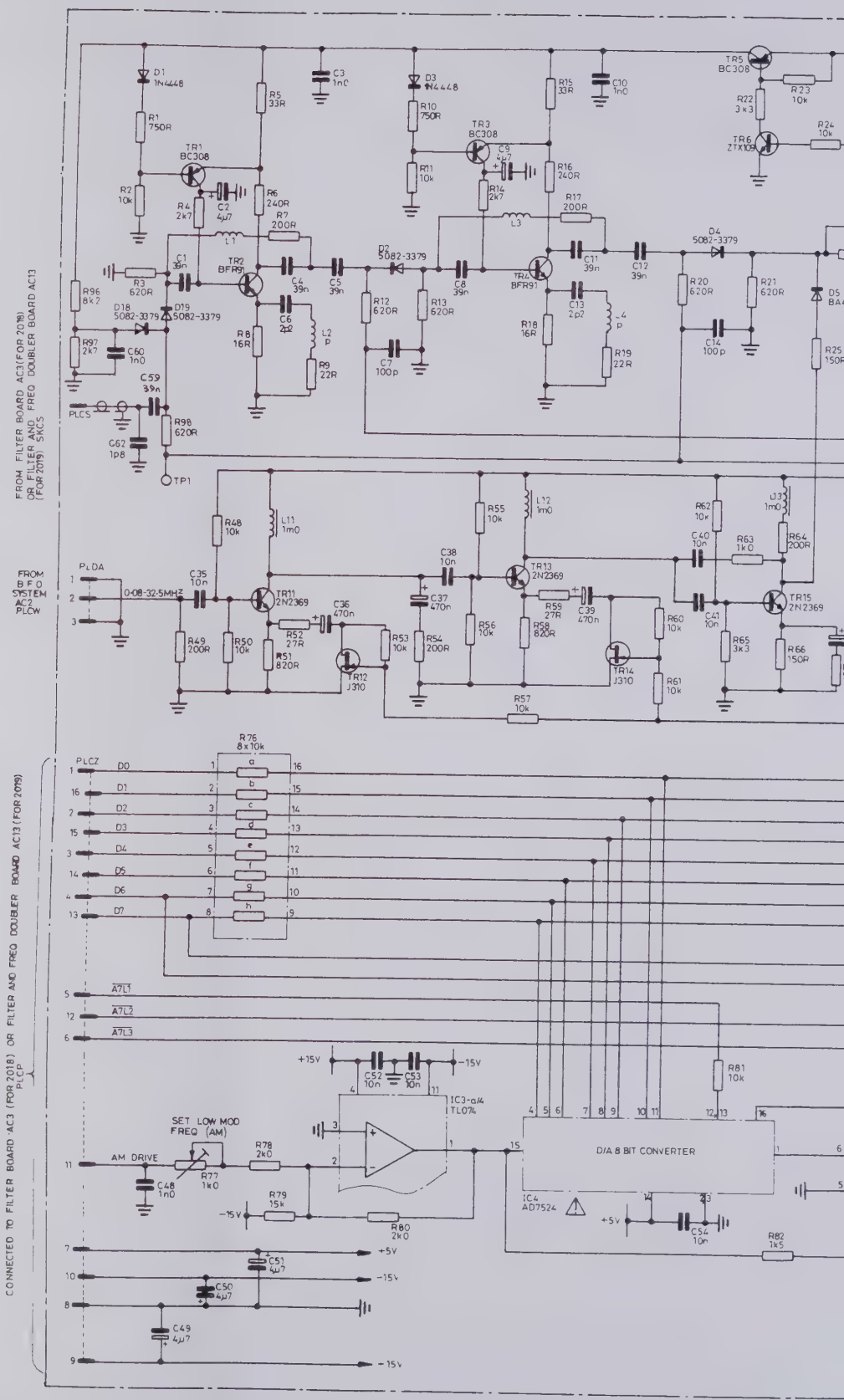
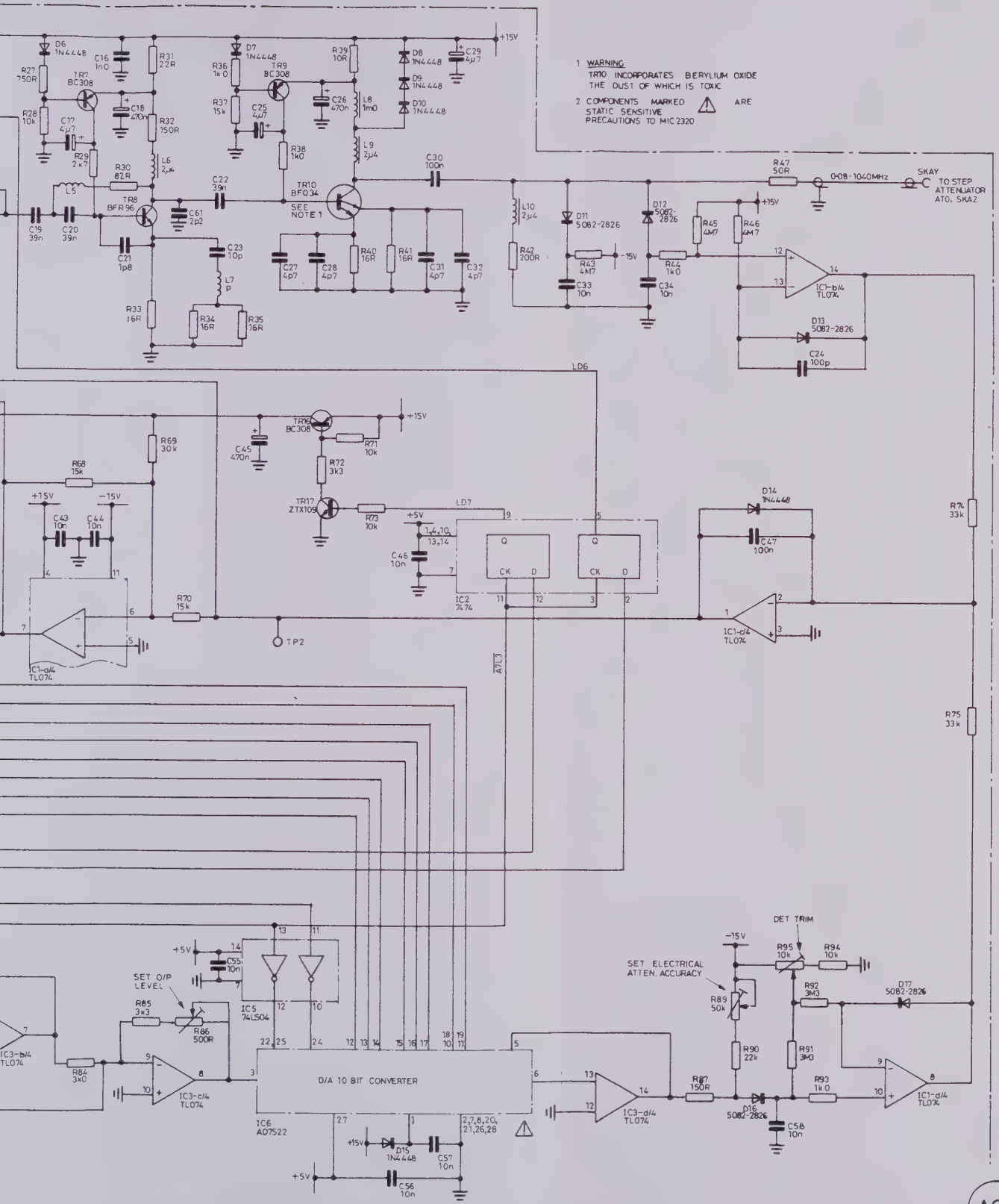
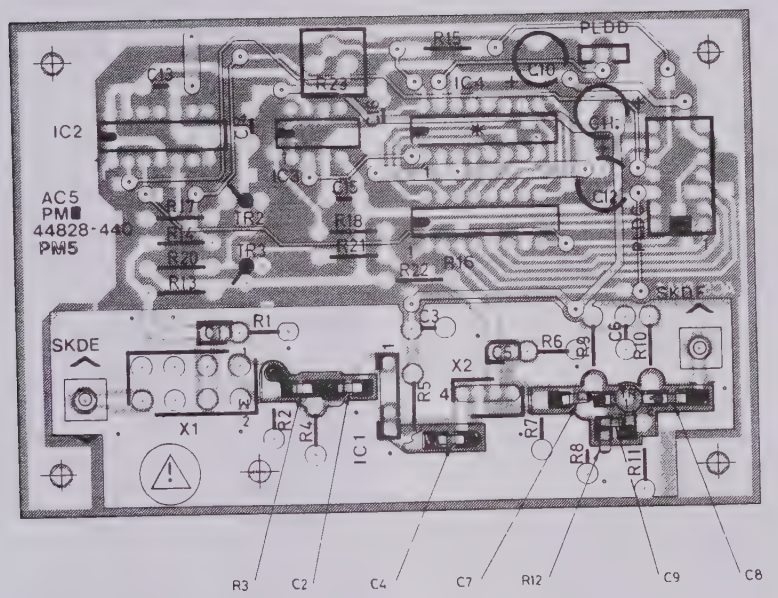

FROM FILTER BOARD AC3(FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13 (FOR 2019) SKCS
FROM B F O SYSTEM AC2 PLCW
CONNECTED TO FILTER BOARD AC3 (FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13 (FOR 2019) PLCP
D/A 8 BIT CONVERTER
IC4 AD7524
SET LOW MOD FREQ (AM)
AM DRIVE
TP1

Fig. 17

Sep. 81


1 WARNING
TR10 INCORPORATES BERYLLIUM OXIDE
THE DUST OF WHICH IS TOXIC
2 COMPONENTS MARKED ⚠ ARE
STATIC SENSITIVE
PRECAUTIONS TO MIC2320
+15V
-15V
+5V
SKAY
TO STEP ATTENUATOR ATO. 5KAZ
0-08-1040MHz
SEE NOTE 1
LD6
LD7
TP2
A7L3
SET O/P LEVEL
SET ELECTRICAL ATTEN. ACCURACY
DET TRIM
D/A 10 BIT CONVERTER
IC1-a/4 TL074
IC1-b/4 TL074
IC1-c/4 TL074
IC1-d/4 TL074
IC2 74174
IC3-b/4 TL074
IC3-c/4 TL074
IC3-d/4 TL074
IC5 74LS04
IC6 AD7522
TR7 BC308
TR8 BFR96
TR9 BC308
TR10 BFQ34
TR16 BC308
TR17 ZTX109
D6 1N4448
D7 1N4448
D8 1N4448
D9 1N4448
D10 1N4448
D11 5082-2826
D12 5082-2826
D13 5082-2826
D14 1N4448
D15 1N4448
D16 5082-2826
D17 5082-2826
R27 750R
R28 10k
R29 2k7
R30 82R
R31 22R
R32 150R
R33 16R
R34 16R
R35 16R
R36 1k0
R37 15k
R38 1k0
R39 10R
R40 16R
R41 16R
R42 200R
R43 4M7
R44 1k0
R45 4M7
R46 4M7
R47 50R
R68 15k
R69 30k
R70 15k
R71 10k
R72 3k3
R73 10k
R74 33k
R75 33k
R84 3k0
R85 3k3
R86 500R
R87 150R
R89 50k
R90 22k
R91 3M3
R92 3M3
R93 1k0
R94 10k
R95 10k
C16 1n0
C17 4µ7
C18 470n
C19 39n
C20 39n
C21 1p8
C22 39n
C23 10p
C24 100p
C25 4µ7
C26 470n
C27 4p7
C28 4p7
C29 4µ7
C30 100n
C31 4p7
C32 4p7
C33 10n
C34 10n
C43 10n
C44 10n
C45 470n
C46 10n
C47 100n
C55 10n
C56 10n
C57 10n
C58 10n
C61 2p2
L5
L6 2µ4
L7 p
L8 1m0
L9 2µ4
L10 2µ4

AC4




Component layout, AC5

Fig. 18a

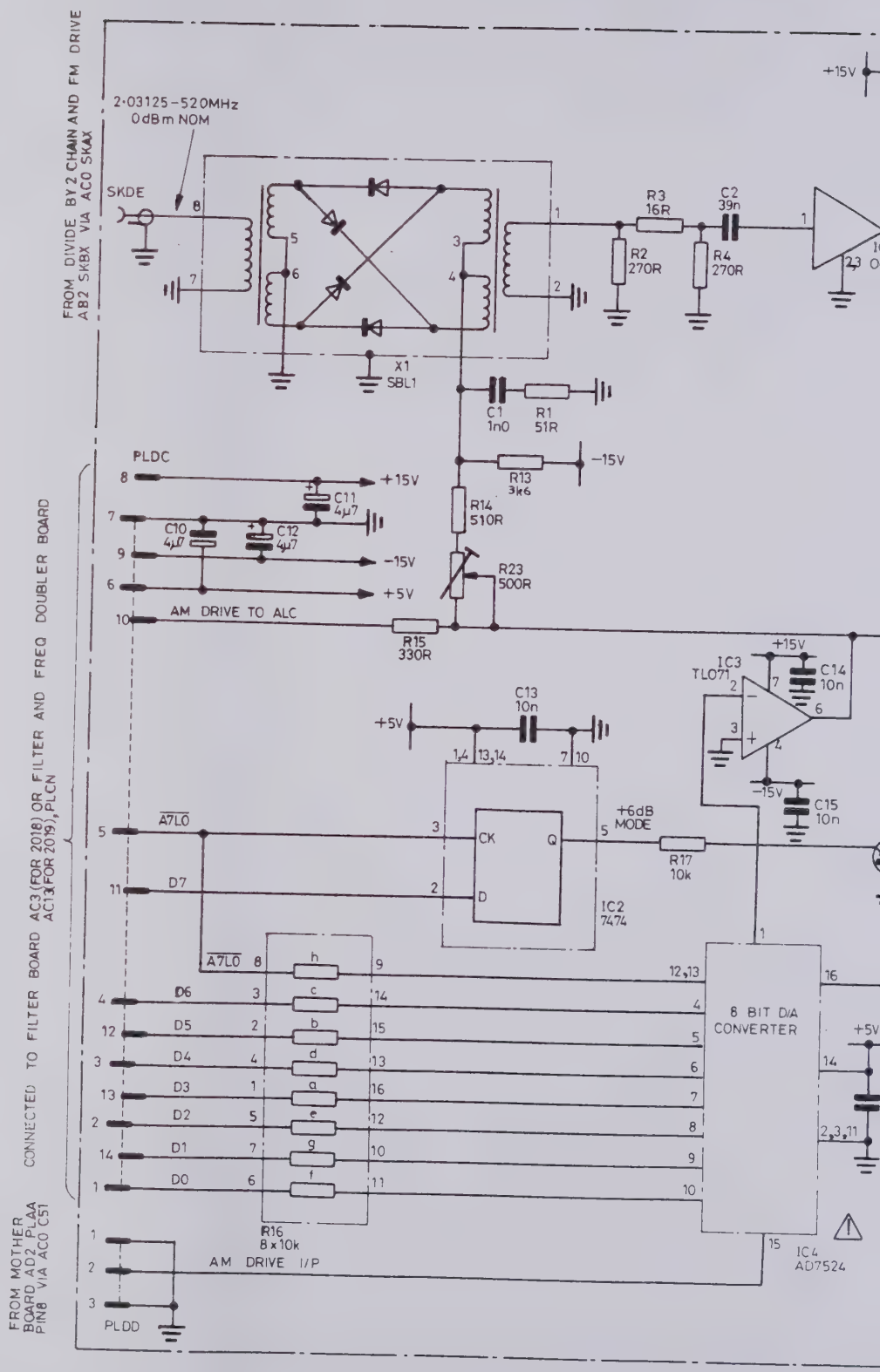
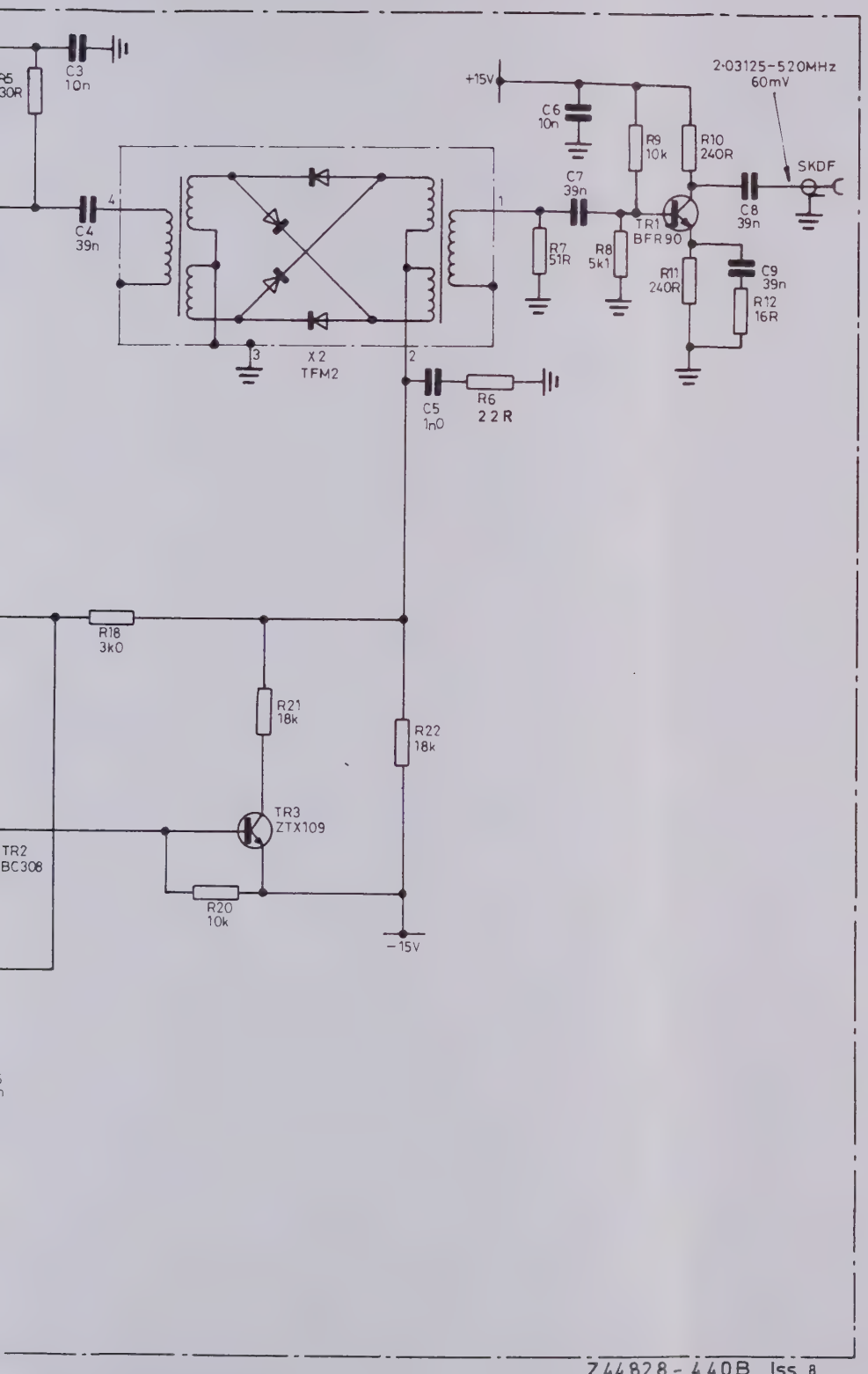

FROM DIVIDE BY 2 CHAIN AND FM DRIVE AB2 SKBX VIA AC0 SKAX
2·03125–520MHz 0dBm NOM
SKDE
X1 SBL1
R3 16R
C2 39n
R2 270R
R4 270R
C1 1n0
R1 51R
+15V
−15V
R13 3k6
R14 510R
R23 500R
PLDC
C11 4µ7
C10 4µ7
C12 4µ7
+5V
AM DRIVE TO ALC
R15 330R
IC3 TL071
C14 10n
C15 10n
C13 10n
A7L0
D7
CK
Q
D
IC2 7474
+6dB MODE
R17 10k
D6
D5
D4
D3
D2
D1
D0
R16 8x10k
AM DRIVE I/P
PLDD
8 BIT D/A CONVERTER
IC4 AD7524
CONNECTED TO FILTER BOARD AC3 (FOR 2018) OR AC13 (FOR 2019), PLCN
FROM MOTHER BOARD AD2 PLAA PIN8 VIA AC0 C51

Fig. 18

Sep. 81

1. COMPONENT MARKED ⚠ IS STATIC SENSITIVE, PRECAUTIONS AS PER MIC 2320

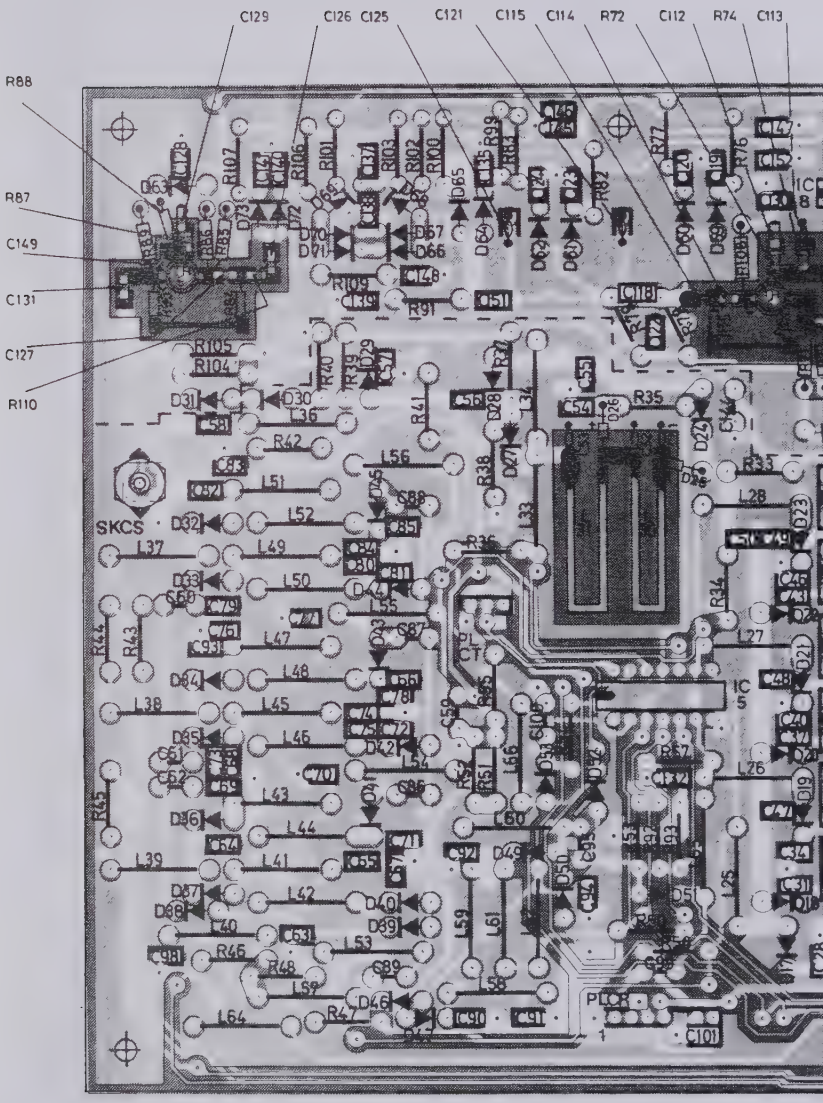



TO FILTER BOARD AC3 (FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13 (FOR2019), C1

Z44828-440B Iss. 8

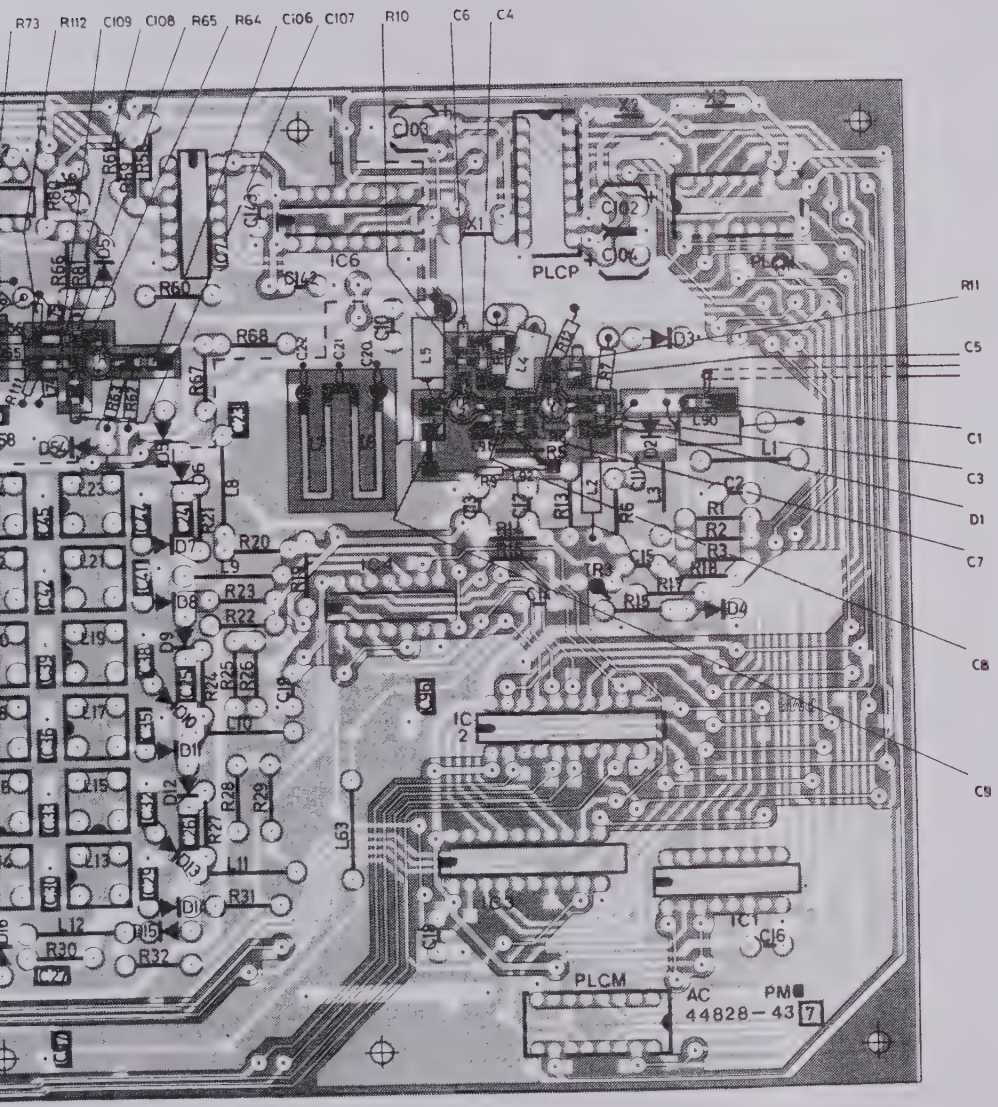
Amplitude modulator, AC5

AC5




Compon

Fig. 19a
Chap. 7
Page 38




nt layout, AC3 & AC13

Fig. 19a

Sep. 81

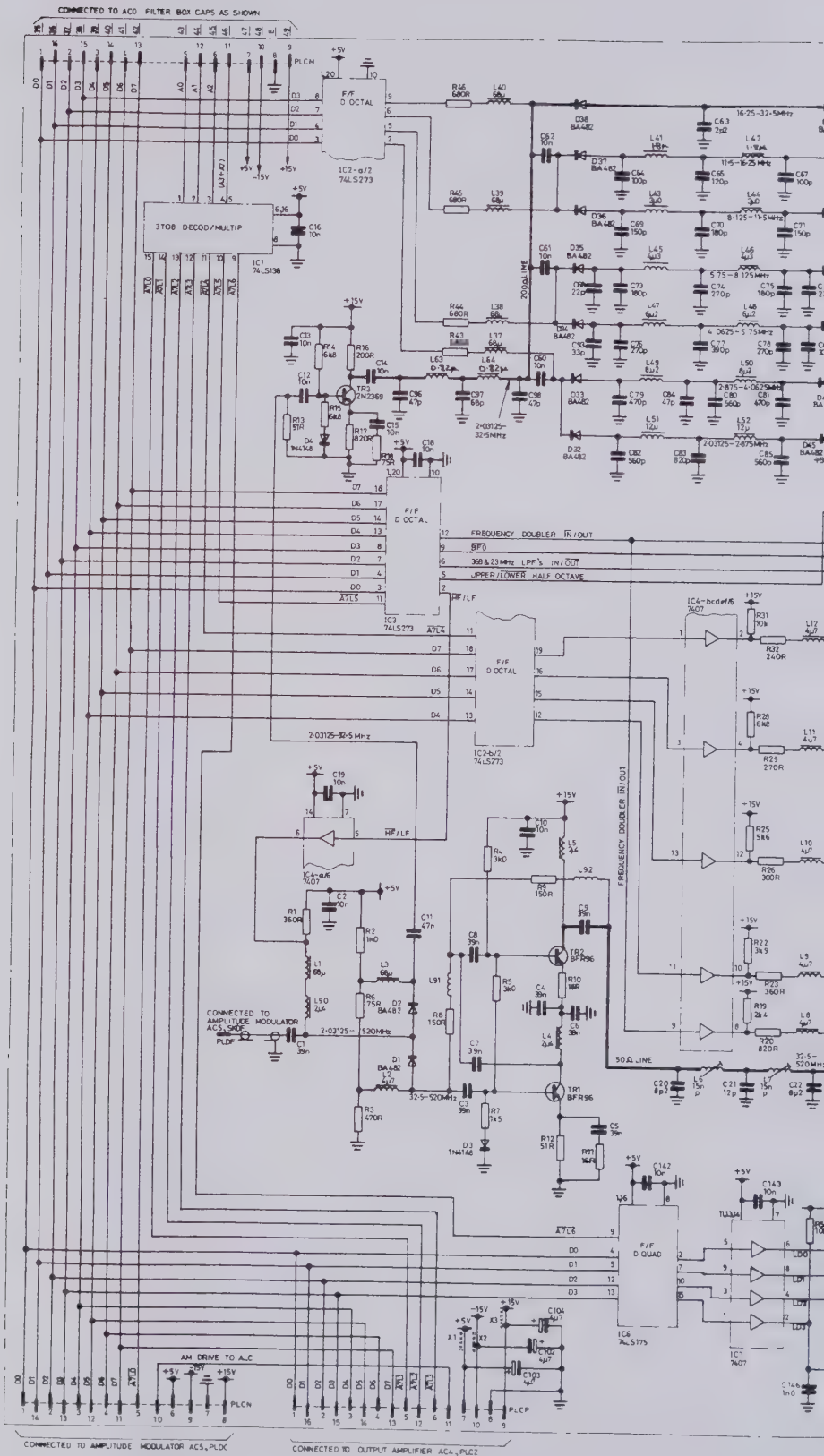
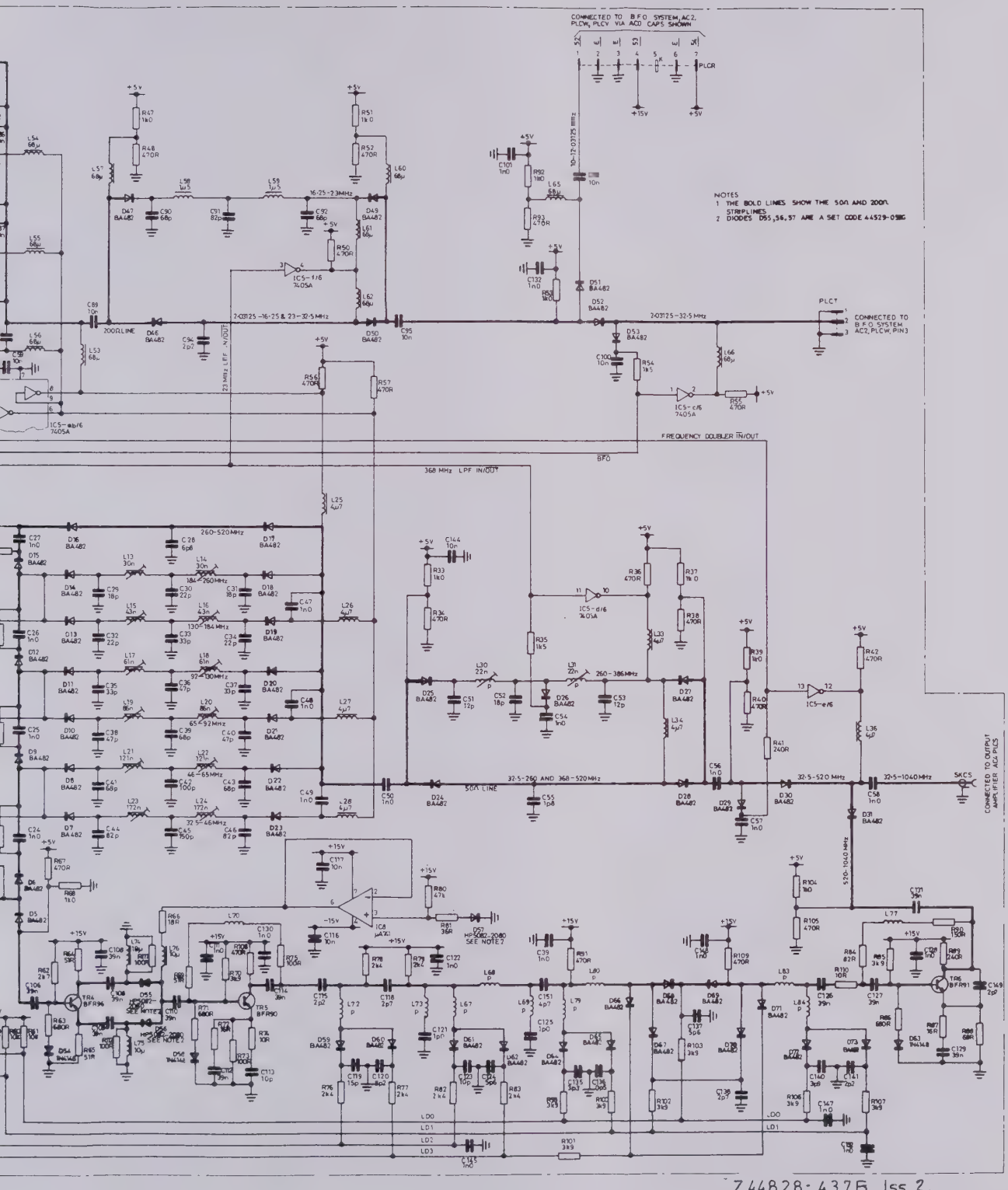



Fig. 19

Filter a

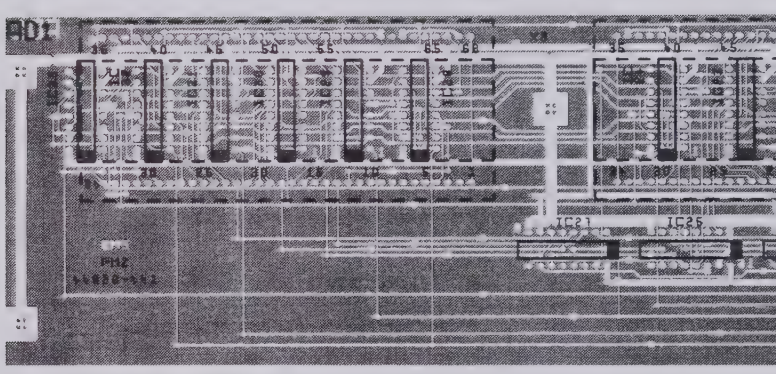
Sep. 81




Z44828-437B Iss. 2.

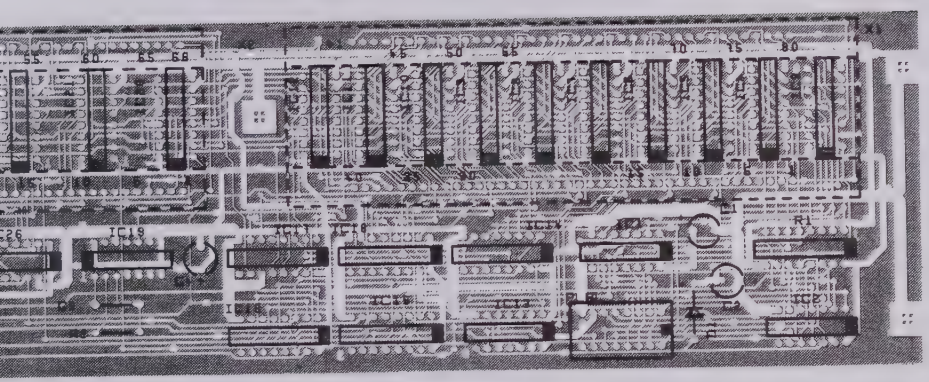
AC13

frequency doubler, AC13 (2019 only)




Comp

Fig. 20a
Chap. 7
Page 40



nent layout, AD1

Fig. 20a

Sep. 81

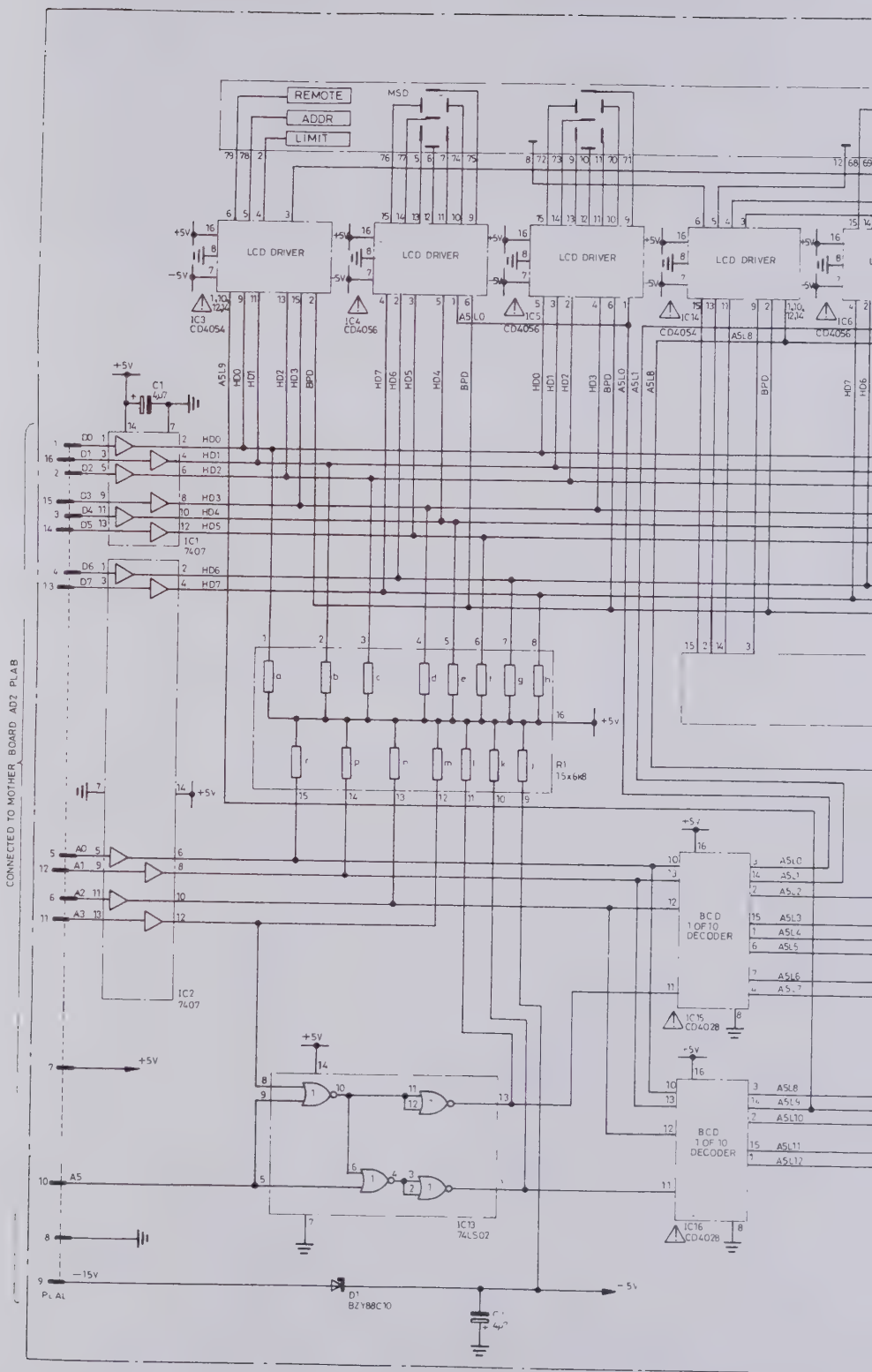
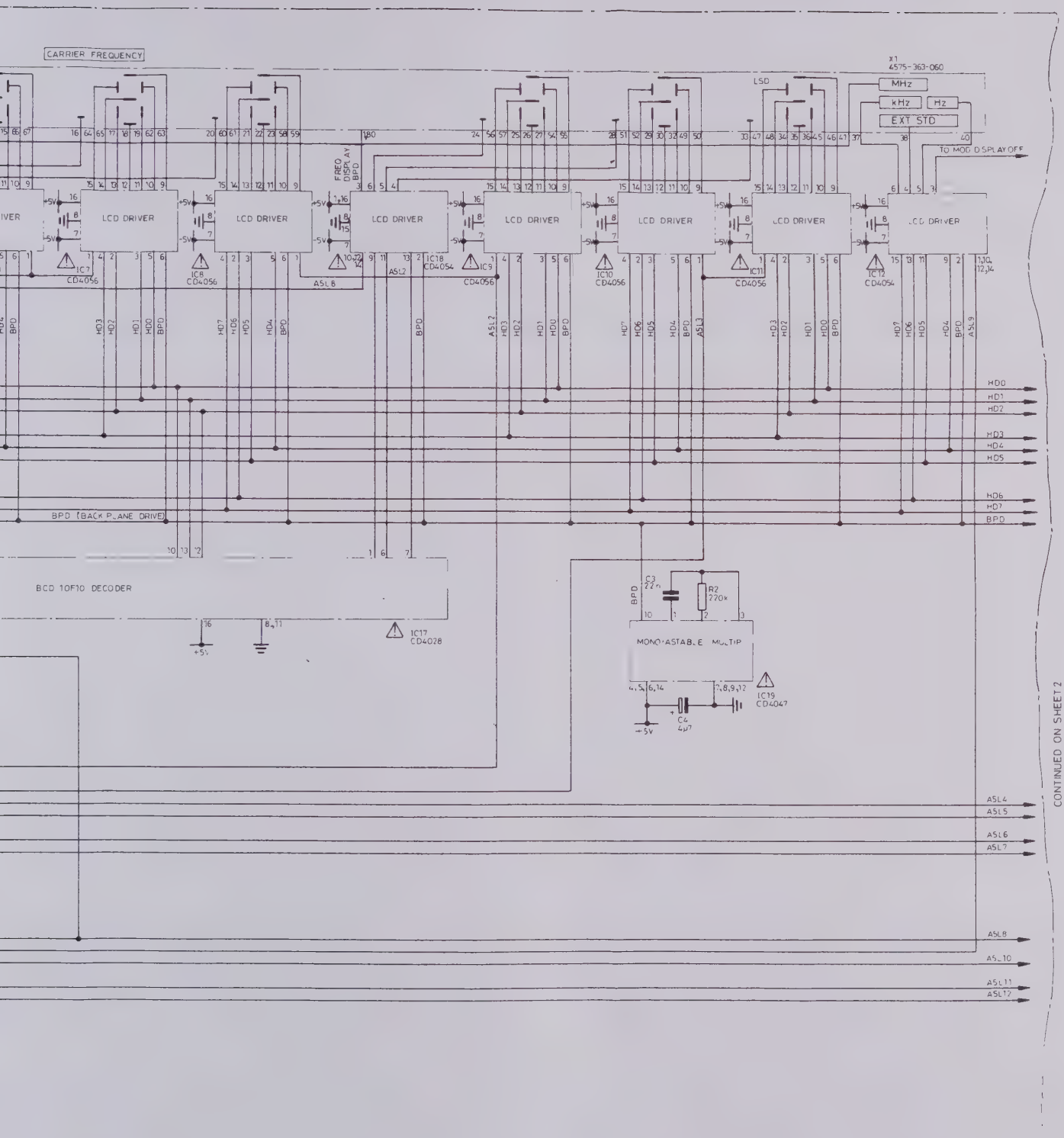

REMOTE
ADDR
LIMIT
MSD
LCD DRIVER
LCD DRIVER
LCD DRIVER
LCD DRIVER
IC3 CD4054
IC4 CD4056
IC5 CD4056
IC14 CD4054
IC6 CD4056
IC1 7407
IC2 7407
R1 15x6x8
BCD 1 OF 10 DECODER
IC15 CD4028
BCD 1 OF 10 DECODER
IC16 CD4028
IC13 74LS02
D1 BZY88C10
+5V
-5V
-15V
CONNECTED TO MOTHER BOARD AD2 PLAB

Fig. 20

Sep. 81




Z44828-441K Iss 5

AD1

Display board, AD1 (sheet 1)

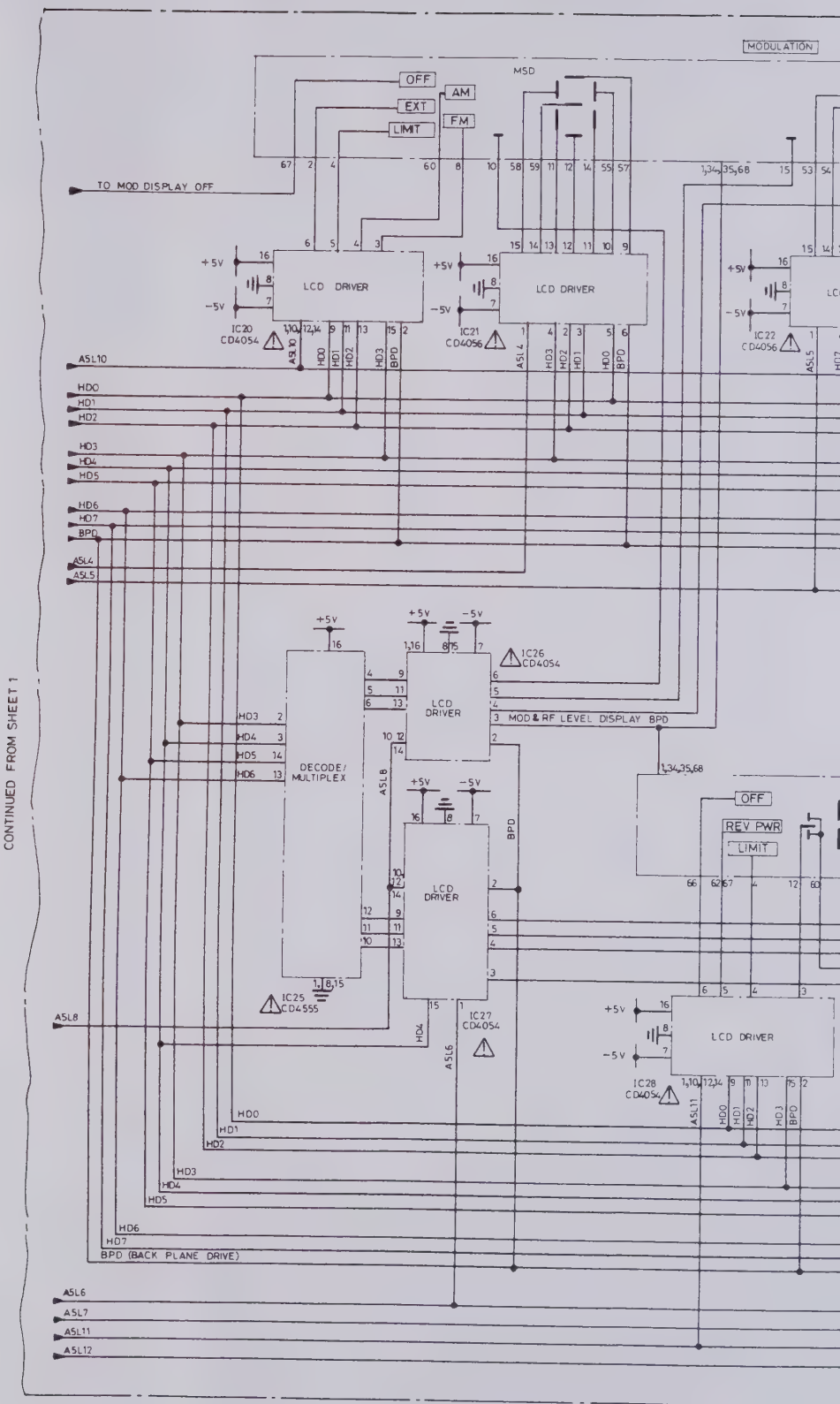
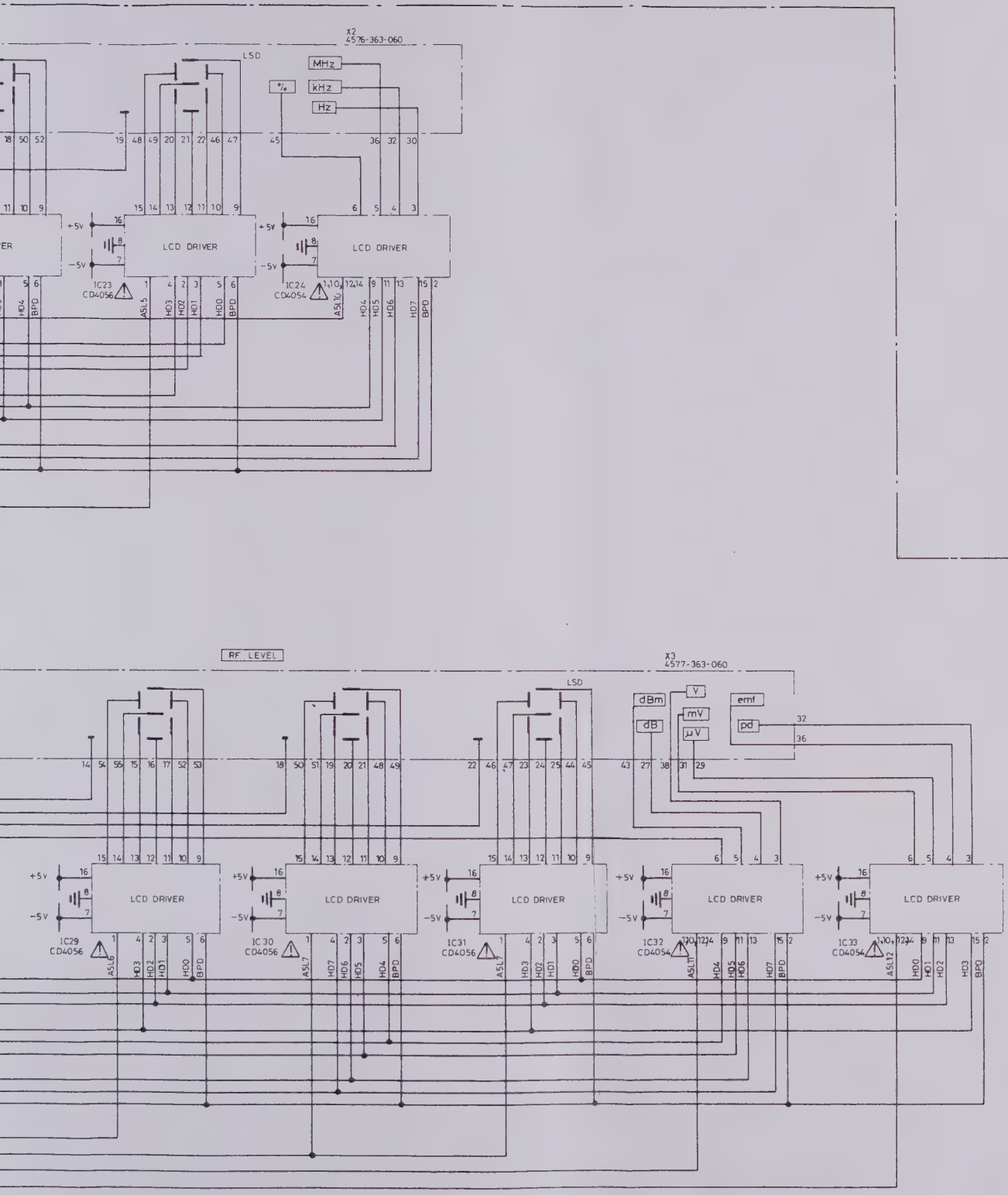

MODULATION
MSD
OFF
AM
EXT
FM
LIMIT
TO MOD DISPLAY OFF
LCD DRIVER
IC20 CD4054
IC21 CD4056
IC22 CD4056
ASL10
HD0
HD1
HD2
HD3
HD4
HD5
HD6
HD7
BPD
ASL4
ASL5
IC26 CD4054
DECODE/ MULTIPLEX
MOD & RF LEVEL DISPLAY BPD
OFF
REV PWR
LIMIT
IC25 CD4555
IC27 CD4054
IC28 CD4054
ASL8
ASL6
ASL11
BPD (BACK PLANE DRIVE)
ASL7
ASL12
CONTINUED FROM SHEET 1

Fig. 21

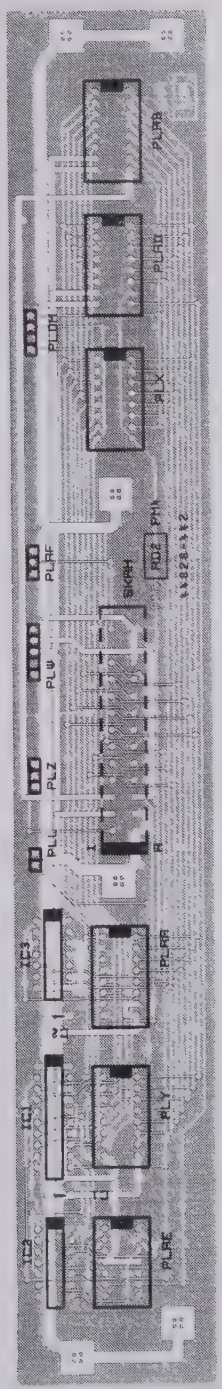
Sep. 81




Display board, AD1 (sheet 2)

Z44828-441K Sh 2 of 2 Iss 4.

AD1




Component layout, AD2

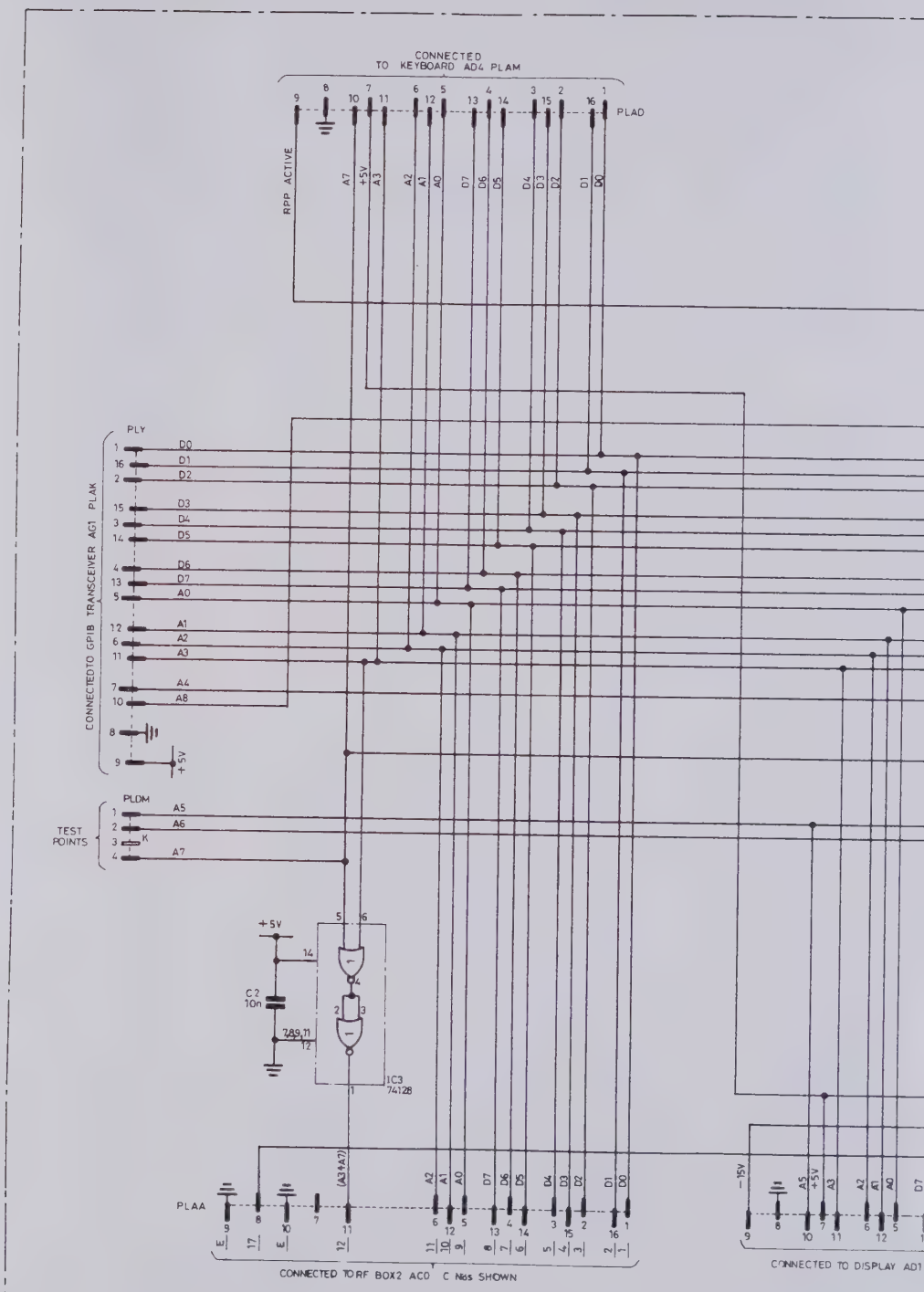
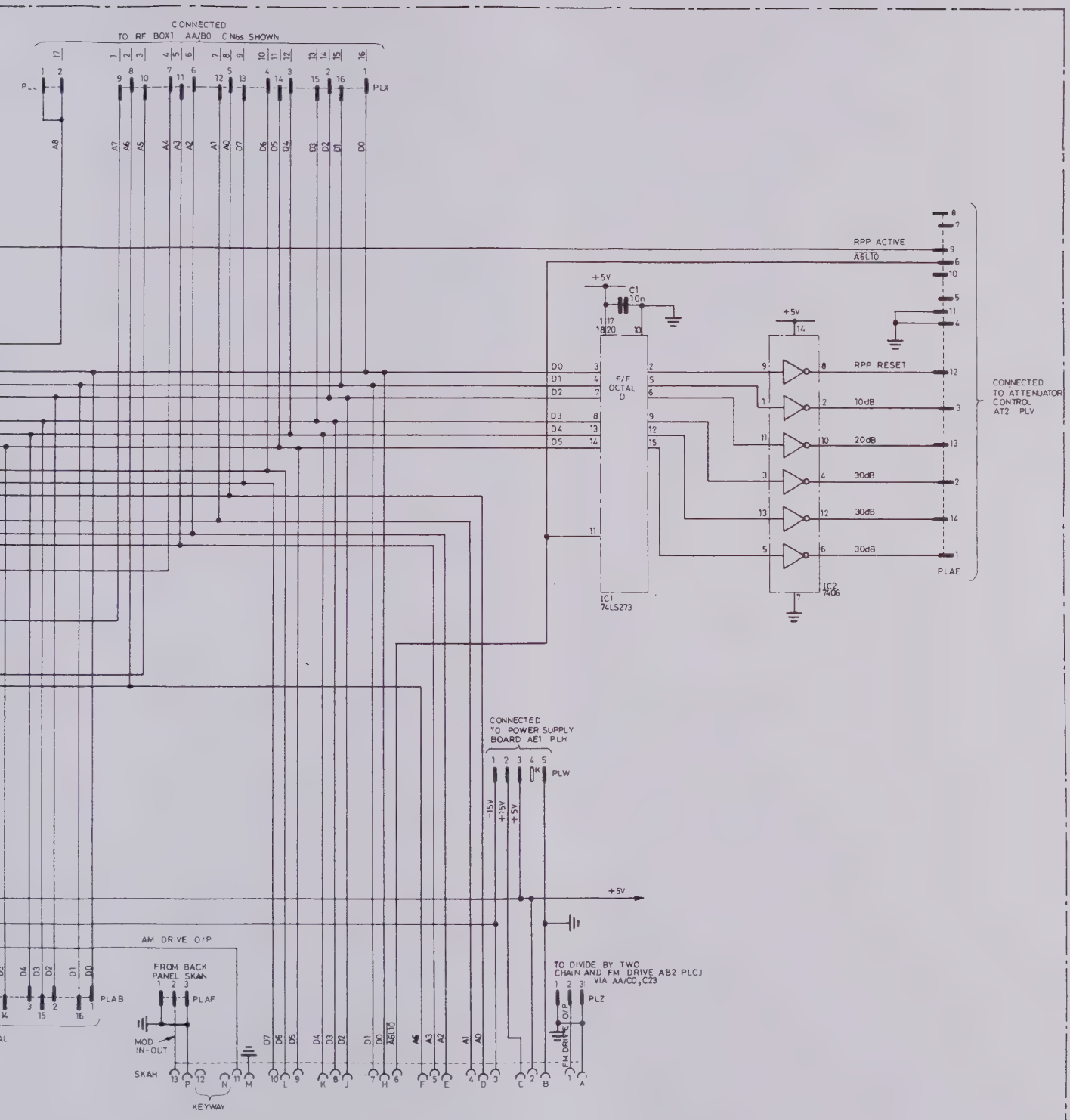

CONNECTED
TO KEYBOARD AD4 PLAM
PLAD
RPP ACTIVE
PLY
CONNECTEDTO GPIB TRANSCEIVER AG1 PLAM
PLDM
TEST
POINTS
+5V
C2
10n
1C3
74128
PLAA
(A3tA7)
CONNECTED TORF BOX2 AC0 C Nos SHOWN
-15V
CONNECTED TO DISPLAY AD1

Fig. 22

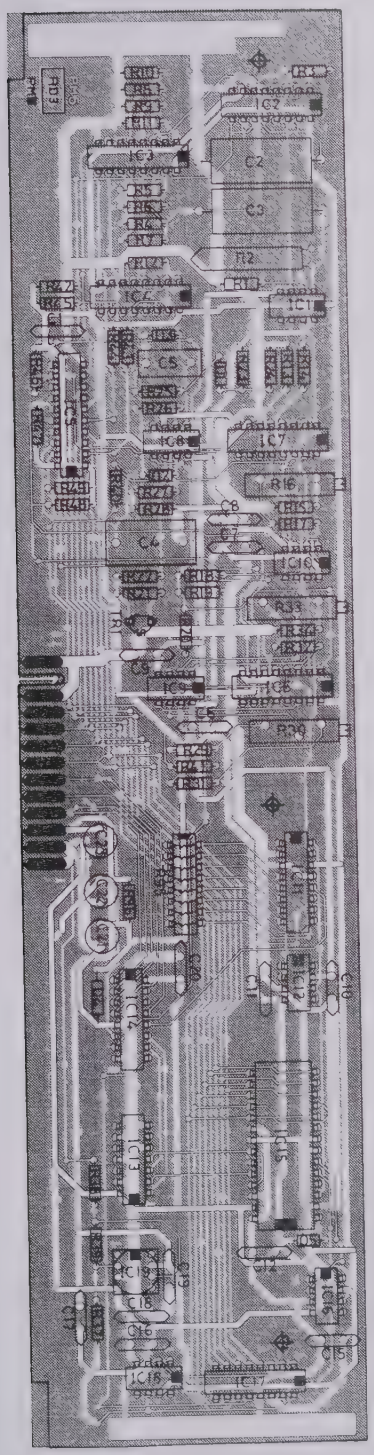
Sep. 81




AD2

Z 44828-442A Iss.6

Motherboard, AD2



Component layout, AD3

Fig. 23a

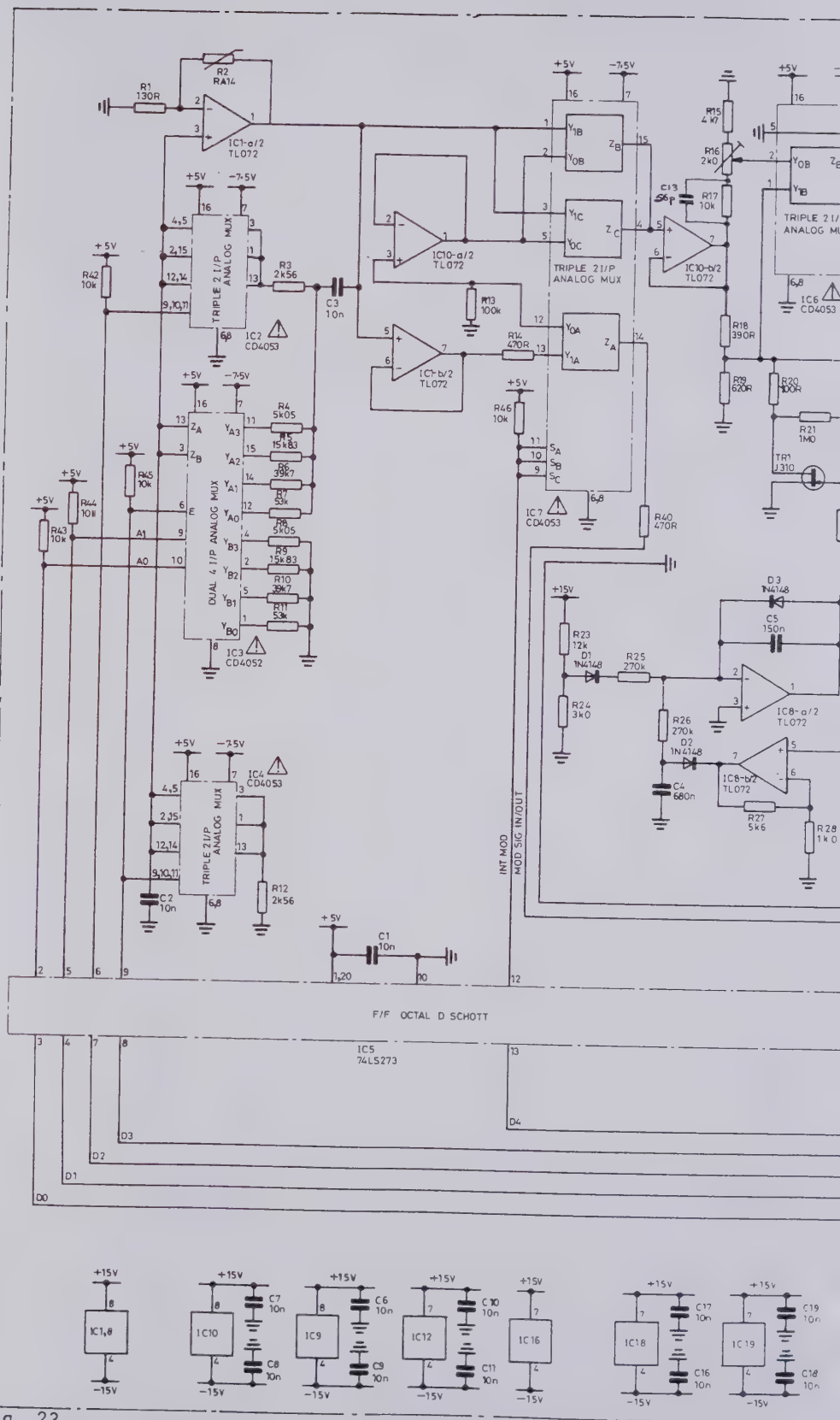
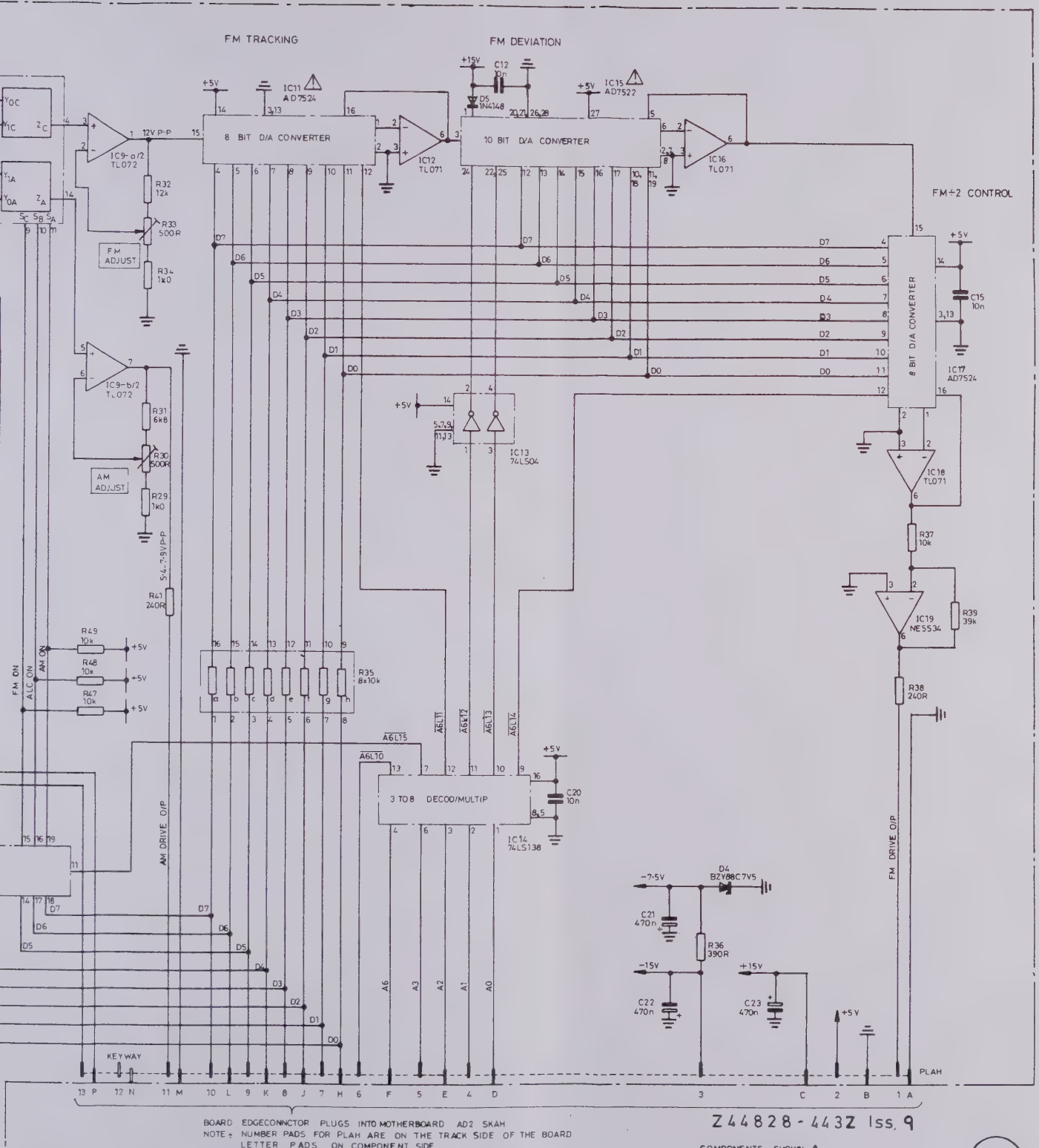
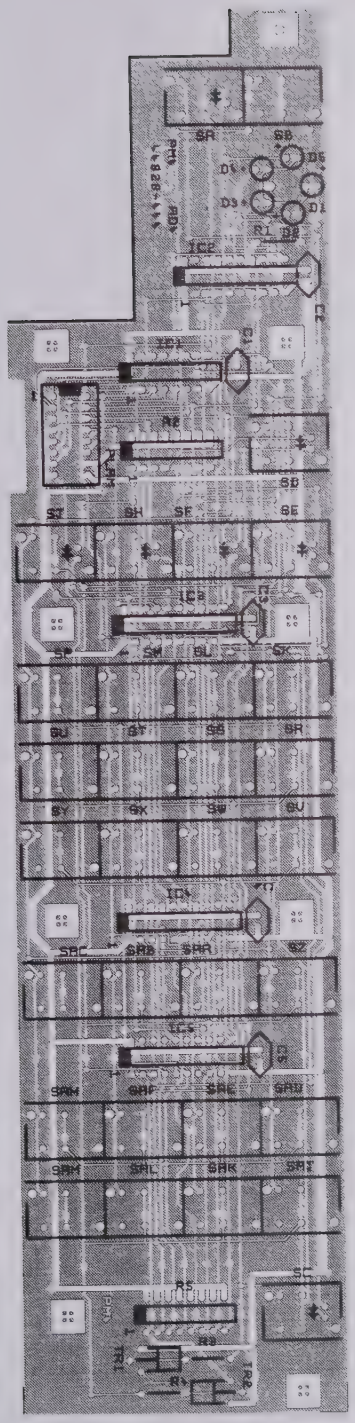

R1 130R
R2 RA14
IC1-a/2 TL072
+5V
-7.5V
TRIPLE 2 I/P ANALOG MUX
IC2 CD4053
R3 2k56
C3 10n
R42 10k
R4 5k05
R5 15k83
R6 39k7
R7 53k
R8 5k05
R9 15k83
R10 39k7
R11 53k
DUAL 4 I/P ANALOG MUX
IC3 CD4052
R43 10k
R44 10k
R45 10k
IC4 CD4053
C2 10n
R12 2k56
C1 10n
IC10-a/2 TL072
IC7-b/2 TL072
R13 100k
R14 470R
IC7 CD4053
R46 10k
R40 470R
IC10-b/2 TL072
R15 4k7
R16 2k0
C13 56p
R17 10k
IC6 CD4053
R18 390R
R19 620R
R20 100R
R21 1M0
TR1 J310
D3 1N4148
C5 150n
R23 12k
D1 1N4148
R25 270k
R24 3k0
IC8-a/2 TL072
R26 270k
D2 1N4148
C4 680n
IC8-b/2 TL072
R27 5k6
R28 1k0
INT MOD
MOD SIG IN/OUT
F/F OCTAL D SCHOTT
IC5 74LS273
D0
D1
D2
D3
D4
IC1,8
IC10
IC9
IC12
IC16
IC18
IC19
C7 10n
C8 10n
C6 10n
C9 10n
C10 10n
C11 10n
C17 10n
C16 10n
C19 10n
C18 10n

Fig. 23

Sep. 81




Modulation oscillator and f.m. control, AD3



Component layout, AD4

Fig. 24a

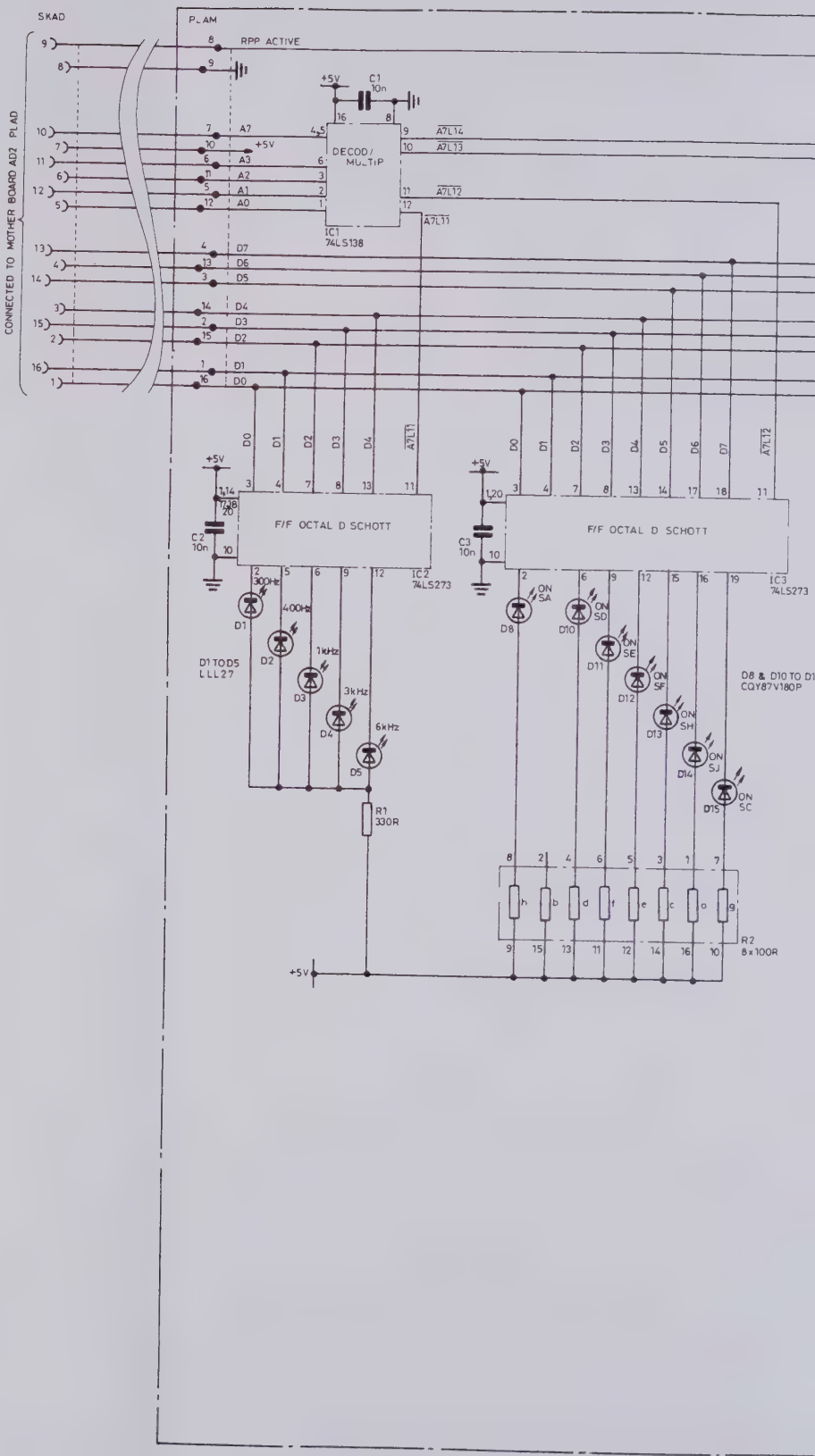
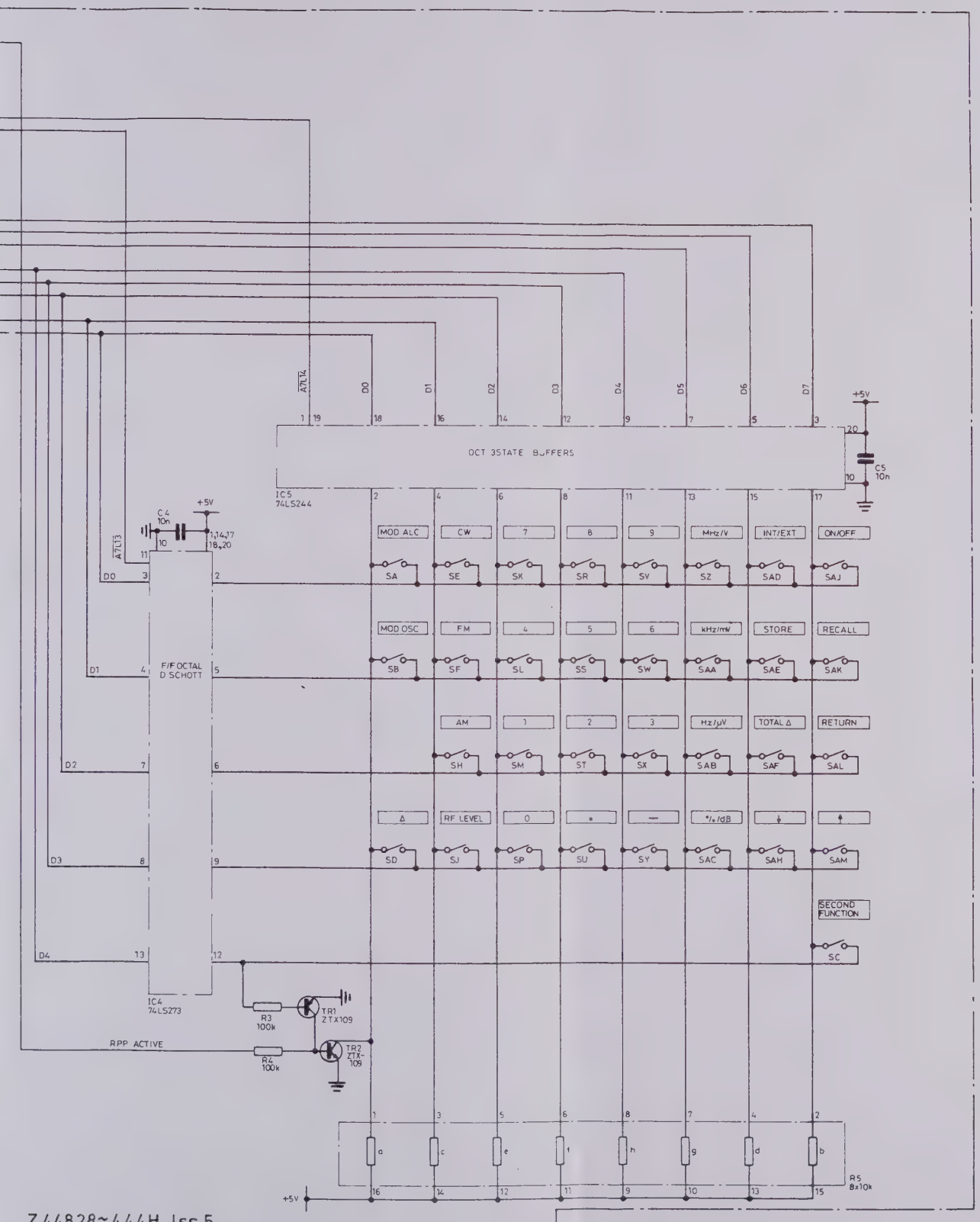

SKAD
PLAM
CONNECTED TO MOTHER BOARD AD2 PLAD
RPP ACTIVE
+5V
C1
10n
DECOD/
MULTIP
IC1
74LS138
A7
A3
A2
A1
A0
D7
D6
D5
D4
D3
D2
D1
D0
F/F OCTAL D SCHOTT
IC2
74LS273
C2
10n
C3
10n
IC3
74LS273
300Hz
400Hz
1kHz
3kHz
6kHz
D1 TO D5
LLL27
D8 & D10 TO D1
CQY87V180P
R1
330R
R2
8x100R

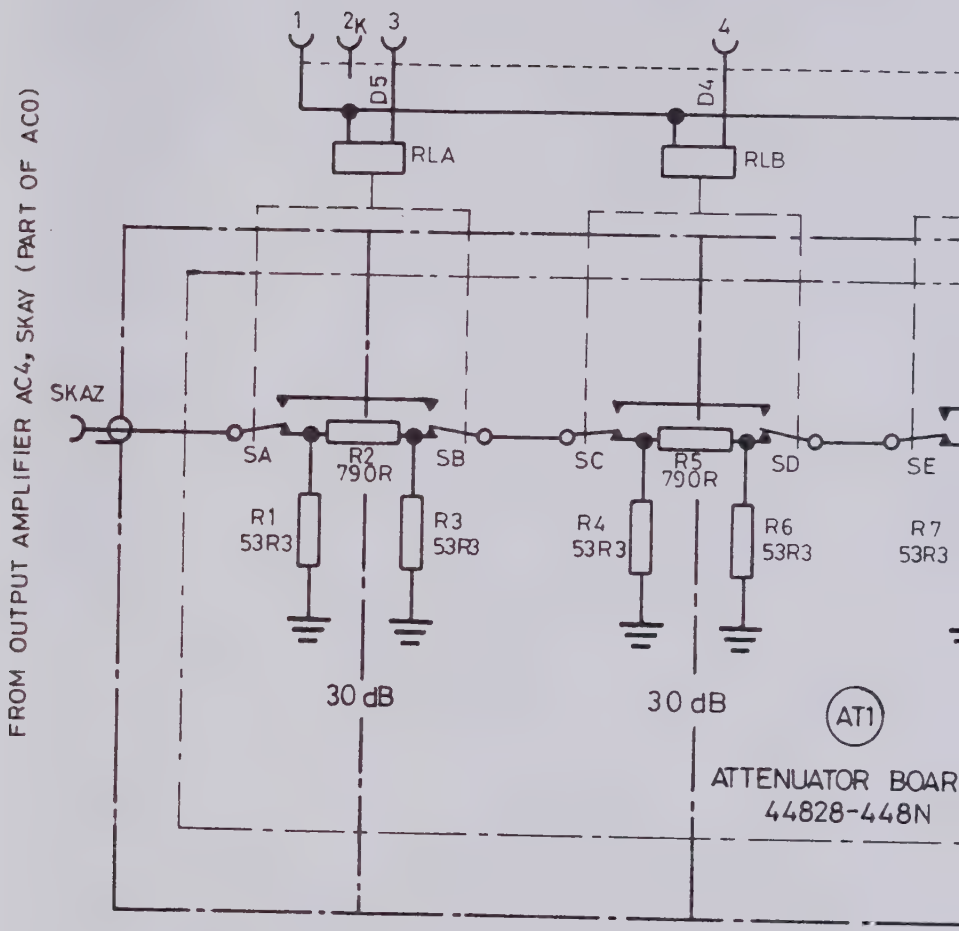
Fig. 24

Sep. 81




Keyboard, AD4

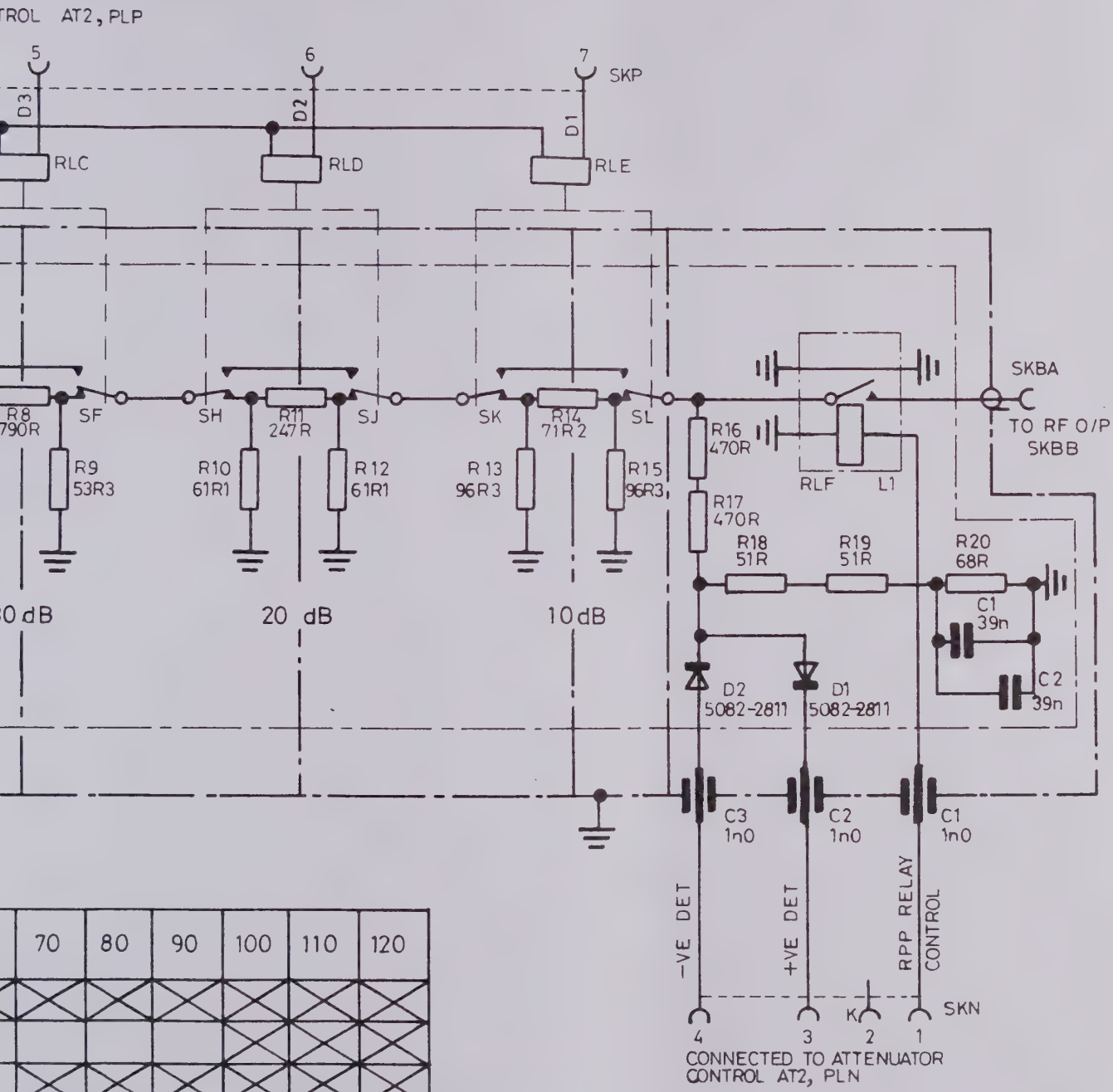
AD4

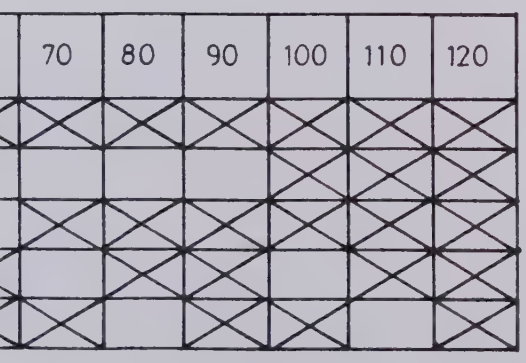



| dB ATTENUATION | | | 0 | 10 | 20 | 30 | 40 | 50 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| PADS IN CIRCUIT | A | 30dB | | | | | X | X | X |
| | B | 30dB | | | | | | | |
| | C | 30dB | | | | | | | |
| | D | 20dB | | | X | X | | X | X |
| | E | 10dB | | X | | X | X | | X |

Fig. 25

Sep. 81



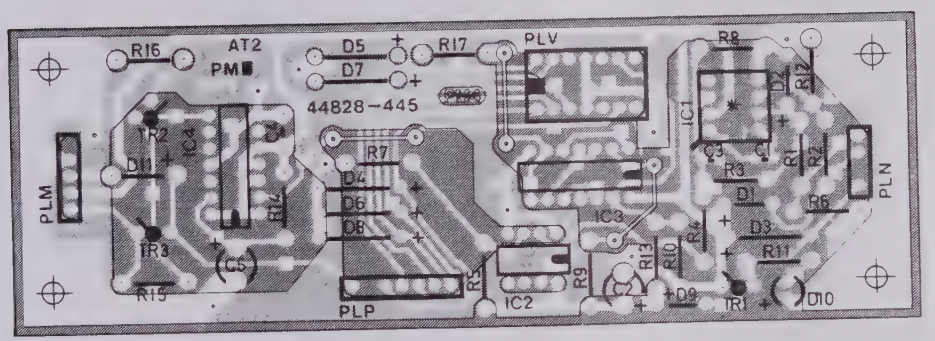




INCLUDES AT1

Z 44 990-353W Iss. 4

AT0

10 dB step attenuator, AT0




Component layout, AT2

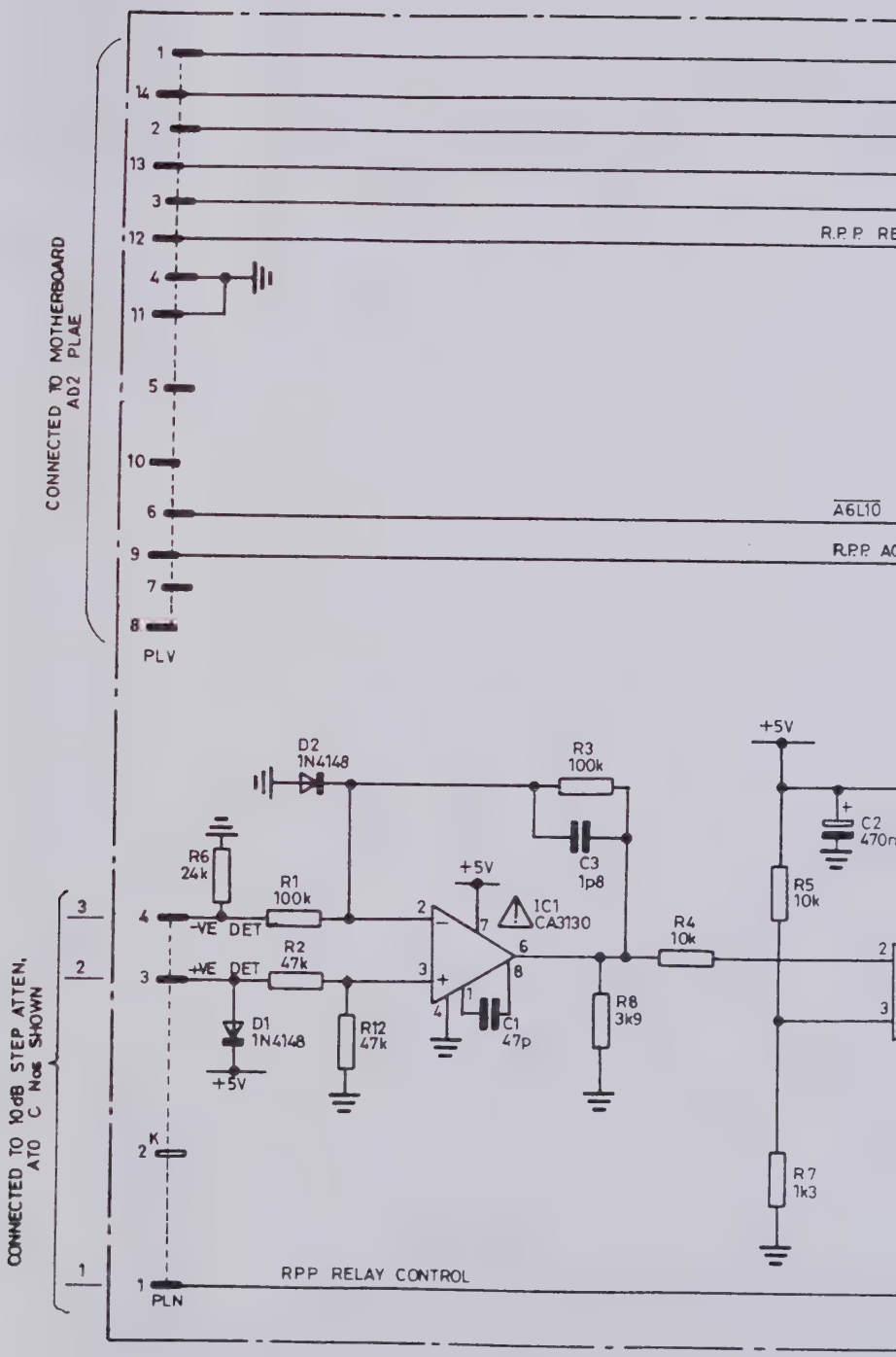
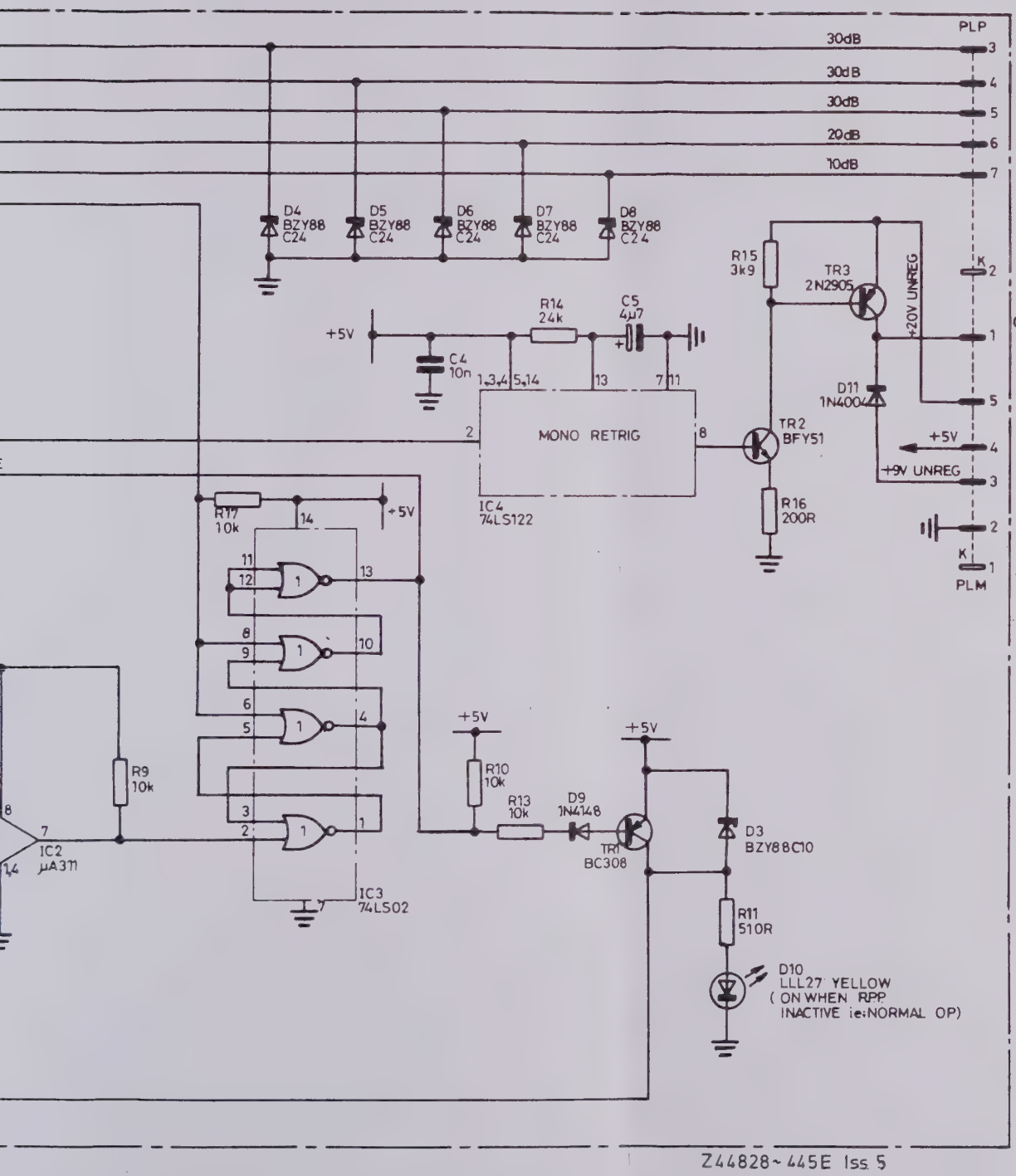

CONNECTED TO MOTHERBOARD A02 PLAE
1
14
2
13
3
12
4
11
5
10
6
9
7
8
PLV
R.P.P. RE
A6L10
R.P.P. AC
D2 1N4148
R3 100k
C3 1p8
+5V
C2 470n
R6 24k
R1 100k
-VE DET
+VE DET
R2 47k
D1 1N4148
+5V
R12 47k
IC1 CA3130
C1 47p
R4 10k
R8 3k9
R5 10k
R7 1k3
CONNECTED TO 10dB STEP ATTEN. AT0 C Not SHOWN
3
2
1
K
PLN
RPP RELAY CONTROL

Fig. 26

Sep. 81

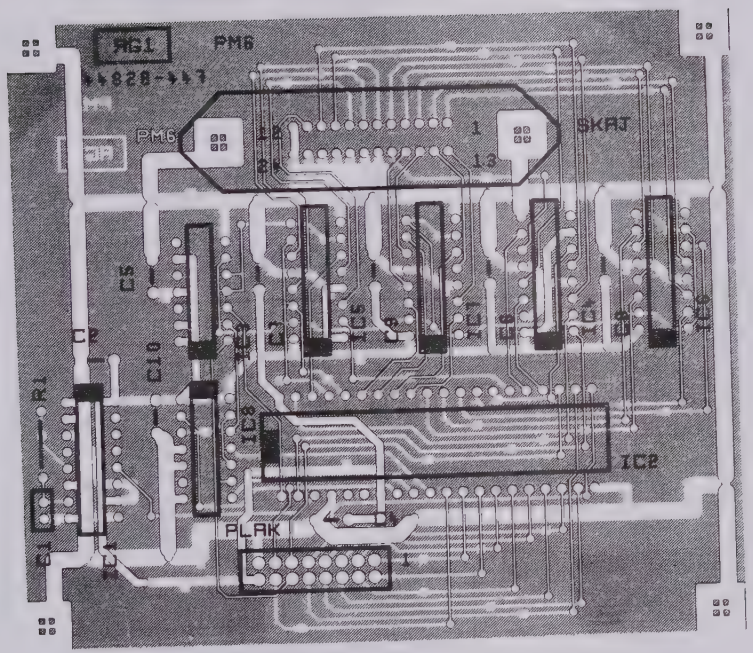
1 COMPONENTS MARKED ⚠ ARE STATIC SENSITIVE PRECAUTIONS AS MIC2320




Z44828~445E Iss 5

AT2

Attenuator control, AT2




Component layout, AG0

Fig. 27a

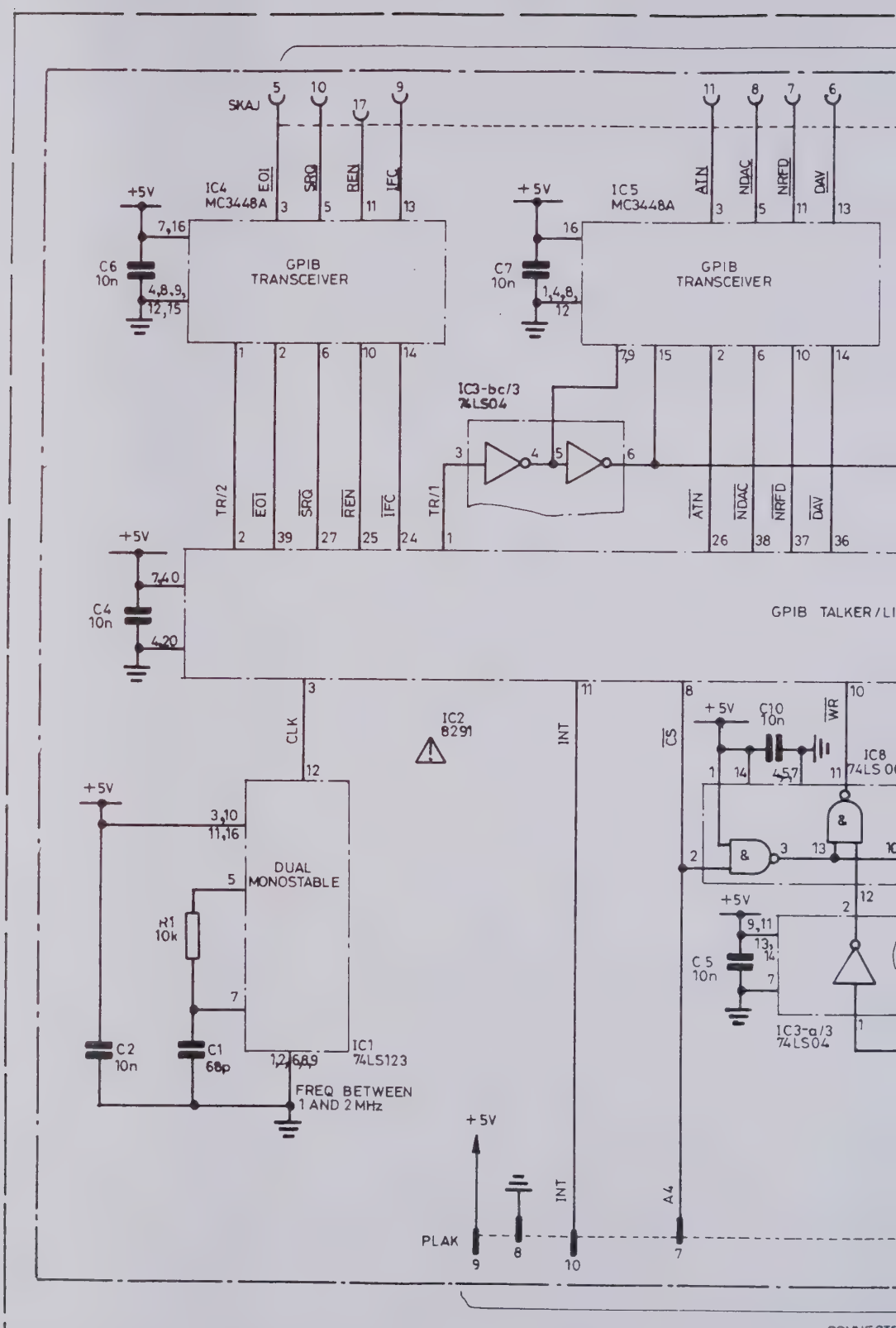
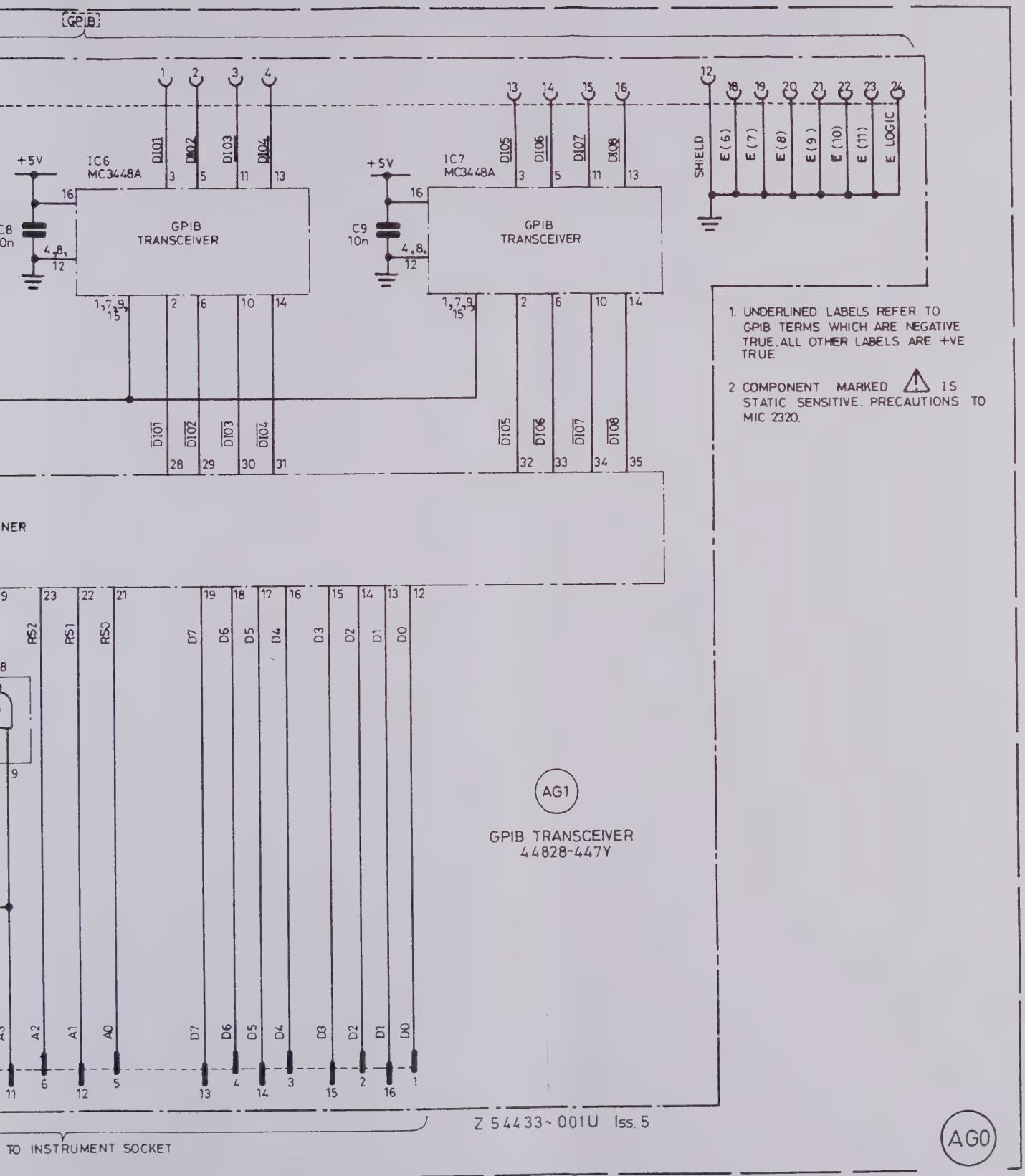



Fig. 27

GPIB

Sep. 81




dapter module, AG0

# MARCONI INSTRUMENTS LIMITED


**UK**

Service Division
The Airport
**LUTON**
Bedfordshire LU2 9NS
Telephone: (0582) 33866
Telex: 825248

Head Office
Longacres
**ST. ALBANS**
Hertfordshire AL4 0JN
Telephone: (0727) 59292
Telex: 23350

Microwave Products Division
Sales and Service
PO Box 10
Gunnels Wood Road
**STEVENAGE**
Hertfordshire SG1 2AU
Telephone: (0438) 2311
Telex: 82159

**FRANCE**

MARCONI INSTRUMENTS
3 Avenue du Maréchal Devaux
**91550 PARAY-VIEILLE-POSTE**
Telephone: 687 36 25
Telex: 203882

**WEST GERMANY**

MARCONI MESSTECHNIK GmbH
Postfach 153
Landsberger Strasse 65
**8034 GERMERING**
Telephone: 089-84 50 85
Telex: 05-212 642

**USA**

MARCONI INSTRUMENTS
Division of Marconi Electronics Inc.
100 Stonehurst Court
**NORTHVALE**
New Jersey 07647
Telephone: (201) 767-7250
TWX: 710-991-9752


*A GEC-Marconi Electronics Company*

Printed in England

CANADIAN MARCONI COMPANY

ELECTRONIC INSTRUMENTS DEPARTMENT

# W A R R A N T Y

Canadian Marconi Company (CMC) warrants each new Electronic Instrument sold by it to be free from defects in material and workmanship, and any Electronic Instrument which so proves defective within 12 months from date of delivery shall be repaired or replaced by CMC free of charge to the original purchaser, PROVIDED:

(a) that CMC receives prompt notice of defect and satisfactory proof thereof establishing that the said Electronic Instrument has been properly maintained and operated within the limits of rated capacity and was not subjected to abuses (CMC's decision in this last instance shall be final and without recourse);

(b) that original purchaser returns the said defective Electronic Instrument to CMC, c/o Electronic Instruments Department, Montreal, Quebec, and assumes all expenses for the transportation (repaired or replaced Electronic Instruments will be returned to the original purchaser at CMC's expenses). Under no circumstances shall CMC be responsible for loss of use and/or for any direct, incidental and/or consequential damages.

The foregoing warranty is the only responsibility of CMC and is in lieu of all other warranties whether expressed or implied.

---

MODEL NO SERIAL NO

---

INSPECTED BY WARRANTY DATE

This Electronic Instrument was thoroughly inspected and performance tested prior to shipment; if received in damaged condition, please file a claim with the carrier and advise Canadian Marconi Company, Electronic Instruments Service Dept. of the damages.

If necessary to return unit
for service, ship to:

CANADIAN MARCONI COMPANY,
ELECTRONIC INSTRUMENTS SERVICE DEPT.
320 Aberdare Road
Door 10
MONTREAL, QUEBEC.

TELEPHONE (514) 341-7630 Ext. 560

COMPAGNIE MARCONI CANADA

SERVICE DES INSTRUMENTS ELECTRONIQUES

# G A R A N T I E

Les instruments électroniques vendus par Compagnie Marconi Canada (CMC) sont garantis contre tout défaut de matériel ou de fabrication. Si de telles défectuosités surviennent dans les 12 mois après la date de livraison à l'acheteur initial, elles seront réparées ou l'instrument électronique remplacé par CMC, sans frais pour l'acheteur initial, POURVU QUE:

(a) l'acheteur initial avise promptement CMC de la défectuosité et fournisse la preuve que ledit instrument électronique a été bien entretenu et utilisé aux seules fins auxquelles il est destiné, et non soumis à un usage abusif (dans ce dernier cas, la décision de CMC sera finale et sans recours);

(b) l'acheteur initial retourne à ses frais l'instrument électronique défectueux à CMC a/s du service des instruments électroniques, Montréal, Québec, (ledit instrument électronique réparé ou remplacé en vertu de la présente garantie sera retourné à l'acheteur initial aux frais de CMC). En aucun temps CMC sera responsable pour la perte d'usage de l'instrument électronique et/ou pour tout dommage direct, indirect et/ou incident.

La présente garantie est la seule responsabilité de CMC et tient lieu de toute autre garantie formelle ou implicite.

| 2018 | 118405/043 |
|---|---|
| NO DU MODELE | NO DE SERIE |
| Claude Lafrenière | 23. 03. 82 |
| VERIFIE PAR | DATE DE LA GARANTIE |

Cet instrument électronique a été inspecté à fond et son fonctionnement vérifié avant la livraison; s'il est endommagé à la réception, faites une réclamation au transporteur et avisez immédiatement CMC, Service de Réparations des Instruments Electroniques, des dommages constatés.

S'il faut retourner l'instrument électronique pour réparation, faites le parvenir à:

COMPAGNIE MARCONI CANADA
SERVICE DE REPARATIONS DES INSTRUMENTS ELECTRONIQUES,
320, rue Aberdare,
Porte 10,
MONTREAL, QUEBEC

TELEPHONE (514) 341-7630 Poste 560

www.manualsplus.com
1014224